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"It's very easy"

says Mr. Bessant of Universal Tools.

. . . to see that this Uke wants more than just good mould making, it's an article that demands a better than usual finish, extreme accuracy in line up between four parts, all with vastly different shrinkage factors and, if you are going to produce a satisfactory instrument, an appreciation of the players' point of view.

It is a satisfactory instrument, and I believe it's the real interest in a customer's problems, backed by 100% craftsmanship and lots of experience that have enabled us to tool up so large a proportion of the outstanding mouldings you see around.

The foundation of successful plastic moulding lies in the mould.

The "Columbian" Ukulele is moulded by Thames Valley Moulders Ltd., for Selcol Products, Ltd. The main moulding, nearly 21" long, is produced on an 8-oz. PECO Injection Moulding Machine and is one of the four parts which go to make up the main body. The interior of the sound board and the fingerboard are scientifically ribbed to provide the essential strength and a further re-inforcement provides location for the steel springs on the friction grip tuning pegs. Experts agree that the instrument has the authentic Ukulele tone.

If it's Tool Trouble phone MITCHAM 1624

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Ekco Plastics also relieve you of the responsibilities of Government test and inspection; their inspection staff are officially approved by A.I.D, Admiralty and all other Government Departments.

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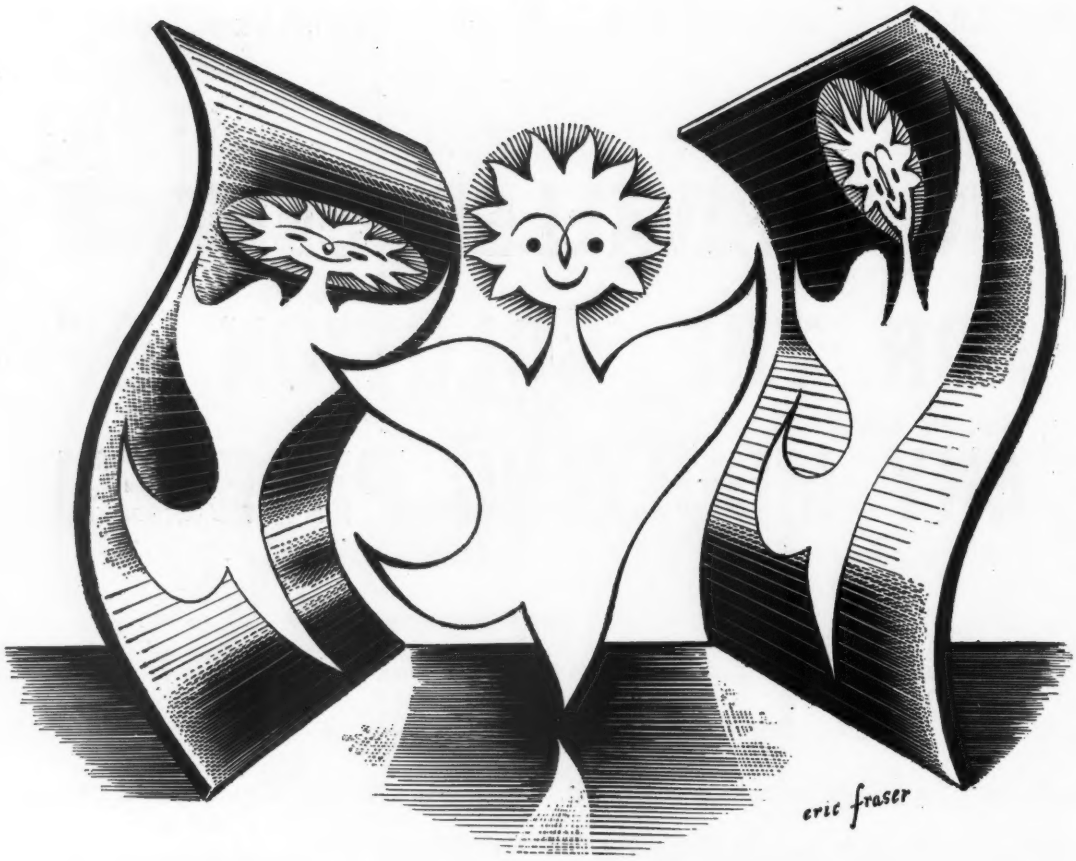

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In particular, the plastics industry has many reasons to be thankful for Mr. Therm's skilled assistance, and one reason is shown in the accompanying photograph. This compact layout of high pressure gas connections, at the works of Messrs. A. F. Bulgin & Co. Ltd., Barking, takes complete care, with its own thermostatic controls, of the heating of platens for moulding parts of electric switches. In a restricted layout such as this, gas provides the perfect answer to many of the plastics industry's heating problems.

MR. THERM BURNS TO SERVE YOU! THE GAS COUNCIL · 1 GROSVENOR PLACE · LONDON · SW1

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BECAUSE

it is the ideal moulding material for the job—so easy to use and admirably suited to large scale production! Examine the handle of this "Eclipse" hacksaw, produced by James Neill & Co. (Sheffield) Ltd., and you appreciate at once why Ashdowns Ltd. mould it in Cellomold cellulose acetate. It has strength, toughness, a fine appearance and is, moreover, warm to the touch. By choosing Cellomold, Ashdowns also secured an important saving in costs. For, besides being available in any colour and in a wide range of finishes and degrees of flow, Cellomold moulding materials are most economical in use. Please write, or telephone, for technical advice on your moulding problems and for a copy of the latest Cellomold Information Booklet.

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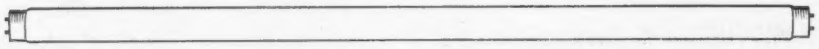

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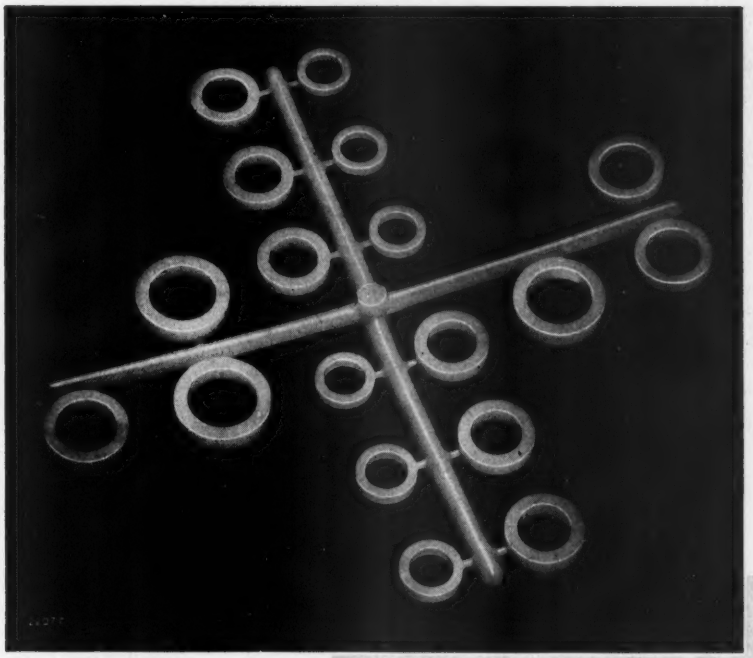
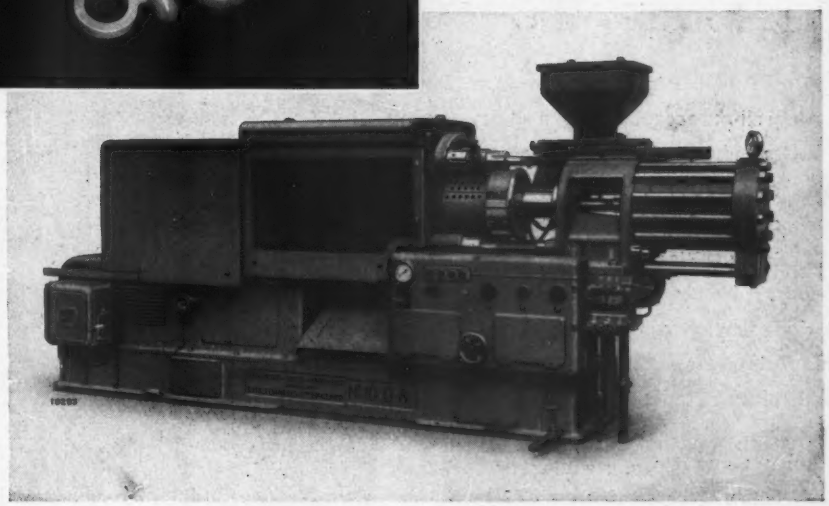


FOR their "Nyloc" self-locking nuts, Simmonds Aerocessories Limited use nylon inserts, moulded by Plastic Engineers Ltd., Treforest, on a Reed-Prentice 10D-8 Injection Moulding Machine.

Catalogue V.1603 describing and illustrating this machine is available on request.

A special injection unit for moulding nylon can now be supplied for the Edgwick Type "HY" Injection Moulding Machine.

We supply a comprehensive range of machinery and equipment for plastic moulding and pressure die-casting, and specialise in the design of dies and moulds. Our specialists are at your service.



REED-PRENTICE 10D-8 INJECTION MOULDING MACHINE

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★ TITEBOND is the time-saving and labour-saving all-purpose bonding medium for the Plastics Industry. Based on one of the new synthetic rubbers, specially treated and compounded, TITEBOND has outstanding adhesive qualities and gives very strong bonds. Its many invaluable qualities include flexibility to prevent cracking of materials, resistance to chemicals and solvents, and resistance to temperature variations. Can be easily applied by brushing, spraying or spreading. A TITEBOND bond is a bond for good.

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for bonding Plastics to Plastics, such as "FORMICA" (Regd.), Plastics to Metal, Metal to Metal, Glass to Fabric, Fabric to Wood, Fabric to Fabric, Leather to Leather, Leather to Paper, Paper to Metal, etc.

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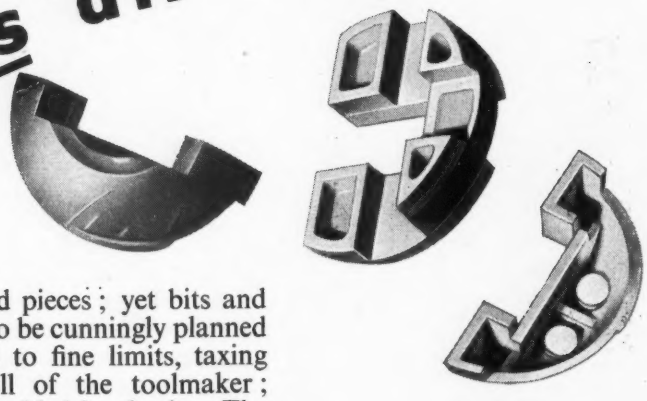
What is all this ?



JUST a few bits and pieces; yet bits and pieces which had to be cunningly planned and carefully designed to fine limits, taxing the ingenuity and skill of the toolmaker; and finally perfectly moulded in plastics. The little gentleman below is the result of assembly of these "puzzle" bits and pieces. He was a real problem which the Plastomatic Service solved.

THE PLASTOMATIC SERVICE

(1) Moulds and delivers at the stipulated times any quantities of any articles already designed and tooled.
(2) Undertakes design and tooling which conform to the mechanical principles that ensure the very finest results in plastics.
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PL/3

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There must have been occasions when you wished to vary your press loading to suit a particular production problem. The McNeil Model 800-32 Electrically-operated Mechanical Goods Press for high-pressure moulding of plastics and rubber will help you overcome your troubles.

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- Motor operated—no hydraulic.
- 800,000 pounds total pressure.
- 32″ × 32″ drilled steam platens.
- 780 pounds per square inch platen pressure.
- Simple speedy adjustment of lower platen.
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- Range of mould thicknesses 1″ minimum to 5″ maximum or 2″ minimum to 6″ maximum.

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MANCHESTER 11 ENGLAND

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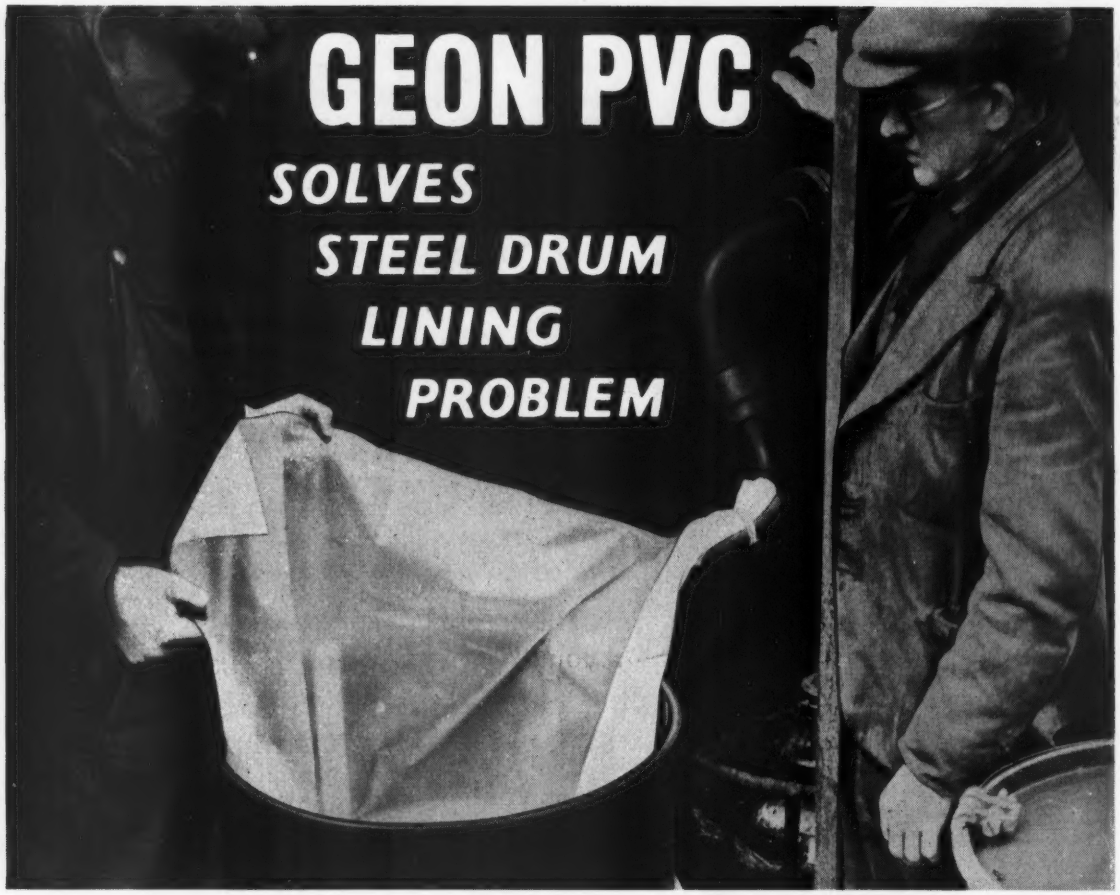

"THE bulk packaging of high quality, surface active chemicals in steel drums for export used to be one of our major problems," say Marchon Products Limited, " and every known method of preventing contamination from the steel had failed—until we investigated the use of plastic sheeting made with Geon PVC." Now, by lining the drums with PVC sheeting made into bags and sealed by electronic welding, hundreds of tons of anionic surface active agents are despatched overseas with every success and absolute safety. . . . But the function of Geon PVC in industry is by no means confined to packaging ! In the form of extrusions, as unsupported film or coated on cloth, it is also used for protective clothing, tank linings, conveyor belting, floorcoverings, hose, tubing, electric cable covering, etc.—in fact, wherever outstanding resistance and durability are essential. Please write for Booklet No.51 which details the properties and uses of Geon polyvinyl chloride plastics materials. *The illustration shows Empicol L. Special Paste, high purity sodium lauryl sulphate made by Marchon Products Limited, being filled into drums lined with "Fablon" sheeting, made with Geon PVC by Commercial Plastics Ltd.*

British Geon Limited

Sales and Technical Service :
21 St. James's Square, London, S.W.1
Telephone : Whitehall 9561

("Geon" is a Registered Trade Mark)

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all in a few weeks

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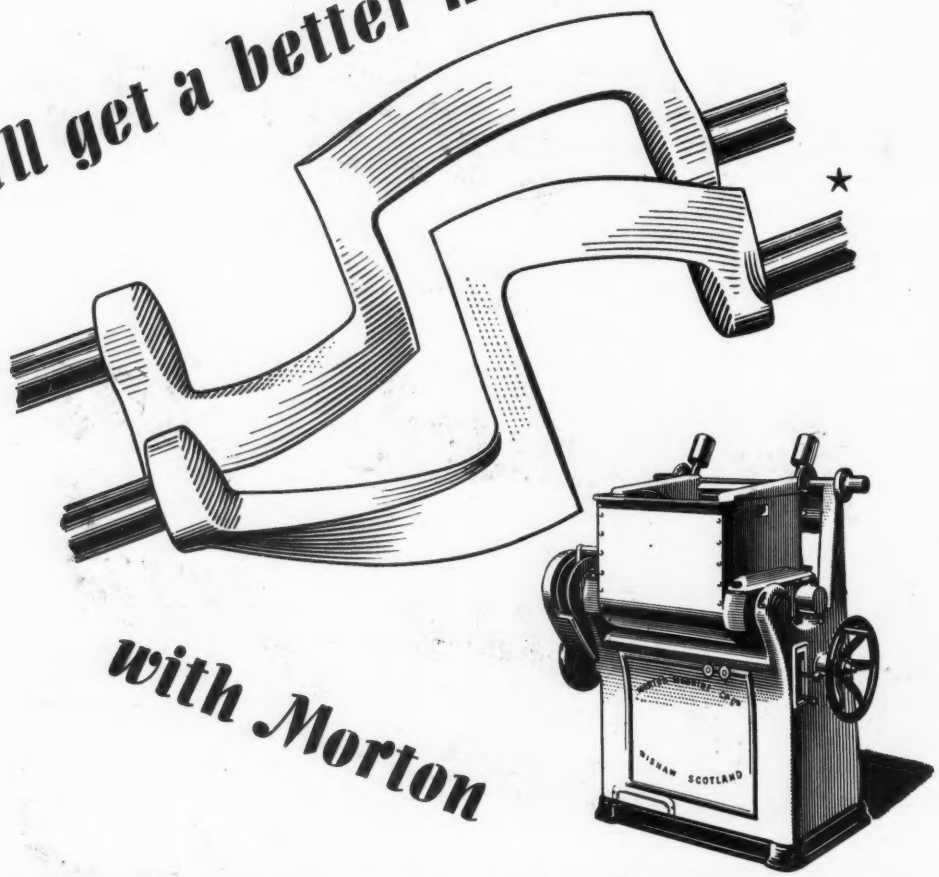
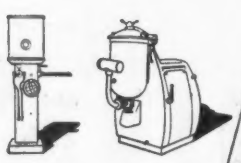


So much depends on the mix that you cannot afford to experiment with your mixing equipment. By constant design and improvement we have developed a range of models which are capable of withstanding the heaviest demands in the most exacting conditions. Standard machines can be adapted or new models designed to your requirements. Our experience of over sixty years is at your service to ensure that you get a better mix.

★ *'Z' type blades can be fitted to all Duplex Mixers.*

Write for descriptive literature or ask for our area representative to call.



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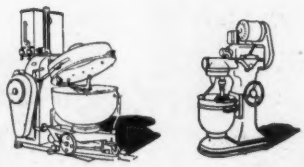

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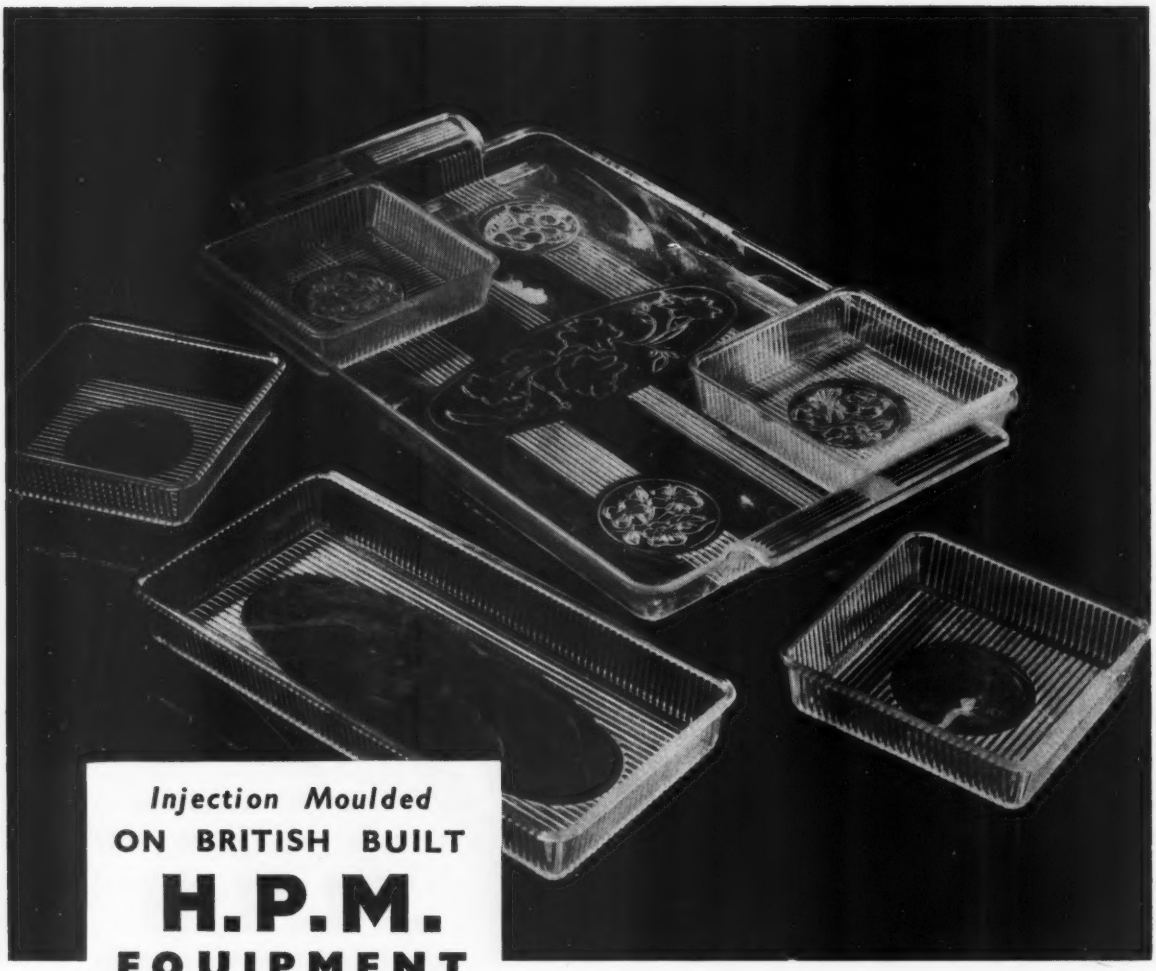
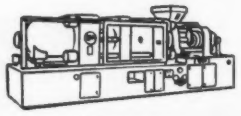


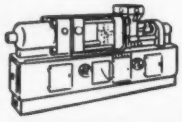
Injection Moulded
ON BRITISH BUILT
H.P.M.
EQUIPMENT

H.P.M. Injection Moulding Machines open up new markets for the plastics moulder. Size and weight are no longer limiting factors. Refrigerator parts, radio cabinets, toilet seats, large instrument housings are typical examples which can now be moulded on a production basis with the new British built H.P.M. equipment. There's a big demand for large plastic parts, are you prepared to make them? Write today for details of the British built H.P.M. range of equipment.

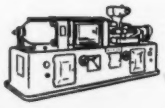
BRITISH HPM BUILT



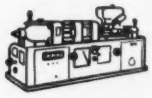
60 ounce



32 ounce



16 ounce



10 ounce

Manufactured under licence by John Shaw & Sons (Salford) Ltd., Salford 3, Lancs.

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Designer's Diary No. 3

The design illustrated in this announcement is of special interest. Conceived and planned by A. H. Woodfull, M.S.I.A., Chief Designer of the B.I.P. Product Design Unit, it gained the Award in the 1951 competition for plastics design, an annual competition sponsored by the Worshipful Company of Horners.

Patent and registered design protection pending.

The Product. This chair has been designed not only to combine all the most desirable practical features, but to provide a truly hygienic piece of nursery furniture. Amongst the most important innovations are the elimination of germ-collecting joints, corners and crevices; and the form of the chair which has been created in sympathy with the natural form of a child's body.

The Design. The design was influenced by the following main considerations:—

Height. Very careful study was made to determine the most convenient height to enable the child easily to be fed.

Stability. Children tend to rock back and forth, rather than from side to side. This chair can safely be tipped up to an angle of 30 degrees.

Tray Hygiene. The tray is easily detachable to facilitate cleaning. It is clamped securely in position by telescopic arms which retract within the tubular structure when tray is not in use.

Footrest. The footrest is adjustable for height by varying the angle, as the child grows.

Moulding Details. The seat would be moulded in a semi-positive two-plate mould, requiring approximately 750 tons moulding pressure. The footrest would need approximately 200 tons, using a similar type of mould. In the case of both these components, the form would be tipped to approximately 45 degrees to the die block; it is thus placed to avoid sheer faces between punch and die and to assist even flow of the material.

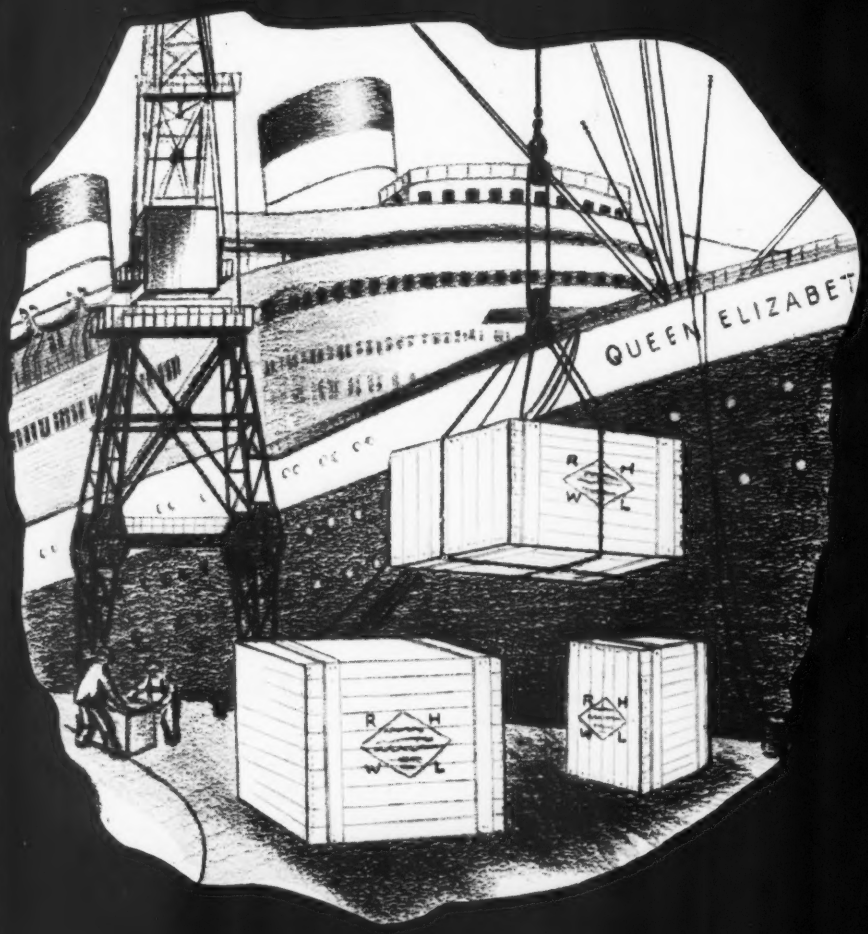
The Material. Beetle urea material for chair, footrest and knobs, chosen for its wide colour range; Beetle Melamine for the tray, because of its excellent resistance to staining and to water.

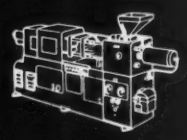
The B.I.P. Technical Advisory Service is always ready to help moulders in any problem which may arise regarding product design, mould design, materials and moulding techniques. This consultative service is freely offered, without obligation, and applies to moulding in thermoplastic as well as thermosetting materials.

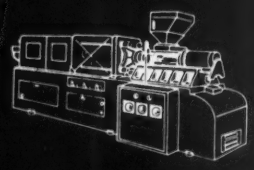
BRITISH INDUSTRIAL PLASTICS LIMITED B·I·P GROUP **1 ARGYLL STREET, LONDON, W.1**

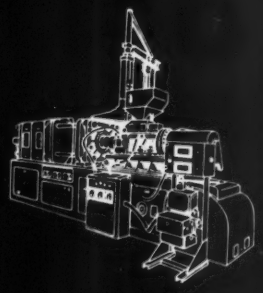
'BEETLE' is a trade mark registered in Great Britain and most countries of the world

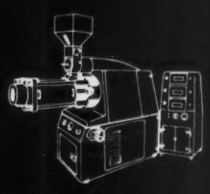
Windsor











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That is why we recommend to you "WELLITE" CELLULOSE ACETATE MOULDING COMPOUND. It is produced in uniform, dust-free, cubical pellets under controlled conditions to ensure uniformity and in a standard range of well over 100 colours. Moreover, we guarantee to match exactly *any* particular shade you want.

Our colours are all tested for fastness and heat resistance and only the finest pigments and dyestuffs are used.

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Telephone: Welwyn 484

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now he leaves them to Lorival

(33)

Lorival continue to provide their customers with a first-class service, in spite of present difficulties. You are invited to consult Lorival about your requirements of ebonite and plastic products.

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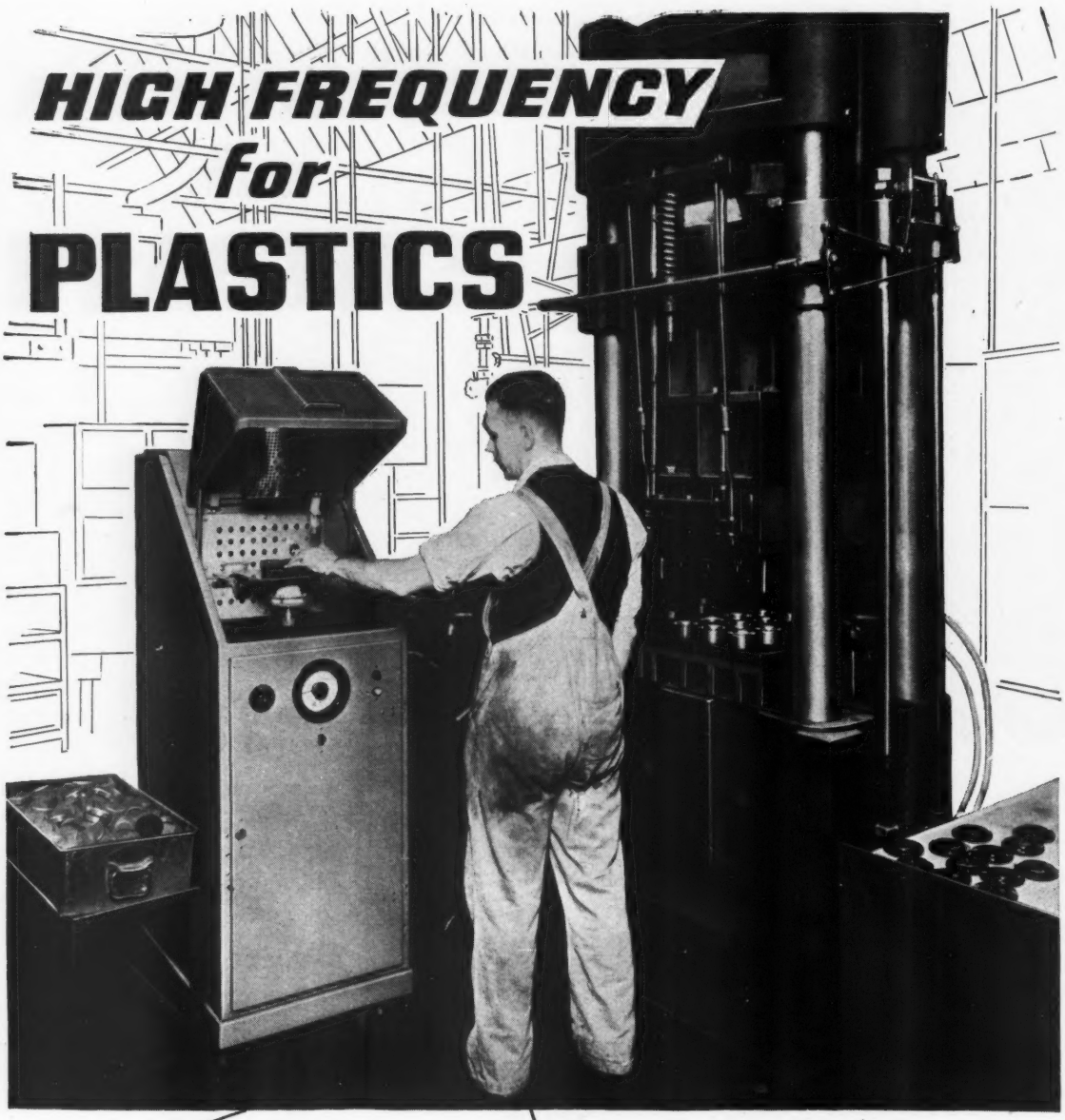
HIGH FREQUENCY for PLASTICS



2 kW Plastic Pre-Heater

High Frequency heating is recognised throughout the Plastics moulding industry as a most effective way of increasing productivity.

Now the G.E.C. 2 kW Plastic Pre-heater, with its robust construction and single valve oscillatory circuit sets a new low standard in maintenance costs.

Leaflet **PH1130** explains fully the many features of this recent addition to the range of G.E.C. High Frequency generators.

by G.E.C.

THE GENERAL ELECTRIC CO. LTD., MAGNET HOUSE, KINGSWAY, LONDON, W.C.2

A new material for seals and bearings

LACRINITE

TRADE MARK

Chief characteristics of "Lacrinite" are:—

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(b) Self-lubrication.
(c) Cheapness in comparison to other materials used for similar purposes.

Already, "Lacrinite" is being used extensively as a sealing material in automotive engineering; it will have many other industrial applications such as the bearings illustrated, which are now undergoing test runs.

Comparative coefficients of friction:

Bonded carbon - -	0.0754
Laminated fabric - -	0.0515
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A LACRINOID PRODUCT

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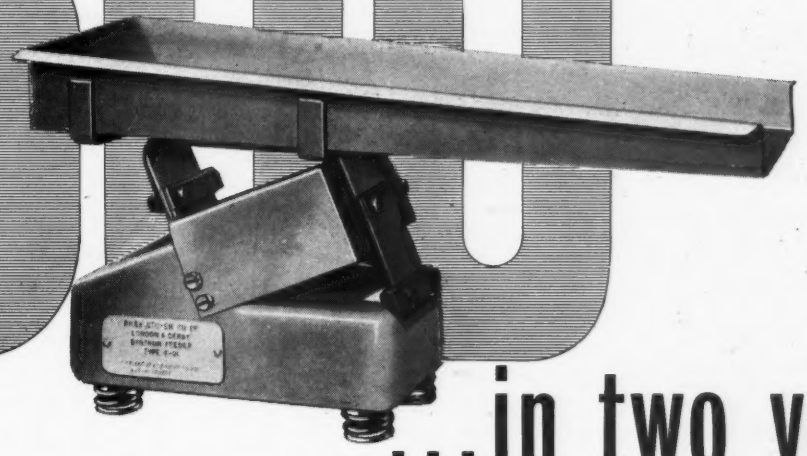

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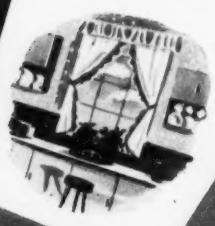

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Typical of the phenomenal progress made in a young industry is this 'Comet,' the first all-jet airliner, a proud contribution to passenger air transport, equalled in the Plastics Industry by Derwent whose development has kept apace of world progress over many years. The moral? If you want an up-to-date moulding—get an up-to-date moulder . . .

let Derwent do it!

MINSTER MOULDINGS

DERWENT PLASTICS LTD., STAMFORD BRIDGE, YORKS. TELEPHONE: STAMFORD BRIDGE 294

ask your moulder . . .

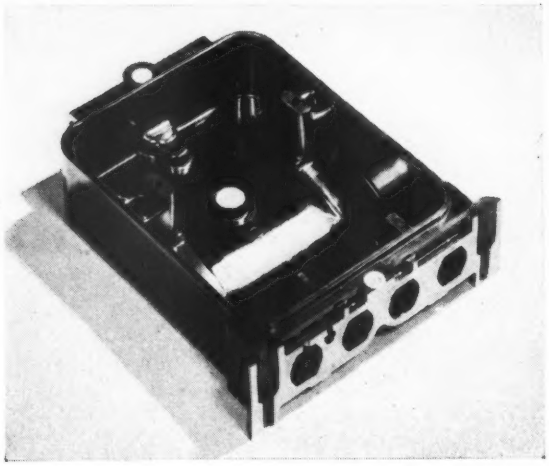
This is the fourth in a series of announcements designed to assist Buyers in purchasing plastics moulded articles or components.

Buyers must sometimes be alarmed by the tendency shown by many moulders to alter specified designs. In their efforts to cut prices, to simplify tools and moulding procedures, moulders have been known to make such changes that the resultant mouldings, though no doubt serviceable, were different from what was originally visualised.

You will have your own very good reasons for laying out a design in a certain way, even though it incorporates unorthodox or inconvenient features. You must be guided, of course, by your moulder's advice as to what can or cannot be moulded but his technical skill should be sufficient to enable him to meet your precise requirements.

When you are negotiating with a moulder, therefore, be very careful to ascertain whether his policy is to mould what *you* want, or to alter your designs to suit his convenience. If a moulder is to prove worthy of your job he should be prepared to exercise his ingenuity to produce it — and to produce it economically — to your specifications.

This does not mean that you should never accept alterations. A good moulder can very often suggest modifications which, without altering the functional purpose of the moulding or detracting from its appearance, can effect a substantial saving of time and money. This point is illustrated in the example given here.



The problem in this moulding (shown sectioned) was the long undercuts. The design was originally laid out so that the cable fixing and shunt insert holes could be cored from the outside. The resulting holes in the end wall were to be filled afterwards by separate mouldings, glued into position. The moulder tackled the job on the basis of withdrawing the cores inwards. This eliminated the need for separate mouldings and their gluing, with a consequent saving in cost; and improved appearance by ensuring that no joint faces would appear on the outside surfaces. Mouldings by The Streetly Manufacturing Co. Ltd. for Ferranti Ltd.

If in doubt, ask **STREETLY**

The Streetly Manufacturing Co. Ltd. makes mouldings in thermosetting and thermoplastic materials and specialises in long runs of the highest quality mouldings. A high percentage of its regular output is of mouldings for manufacturers of electrical equipment and accessories. If you have a moulding job in view, call in Streetly for practical, down-to-earth advice.

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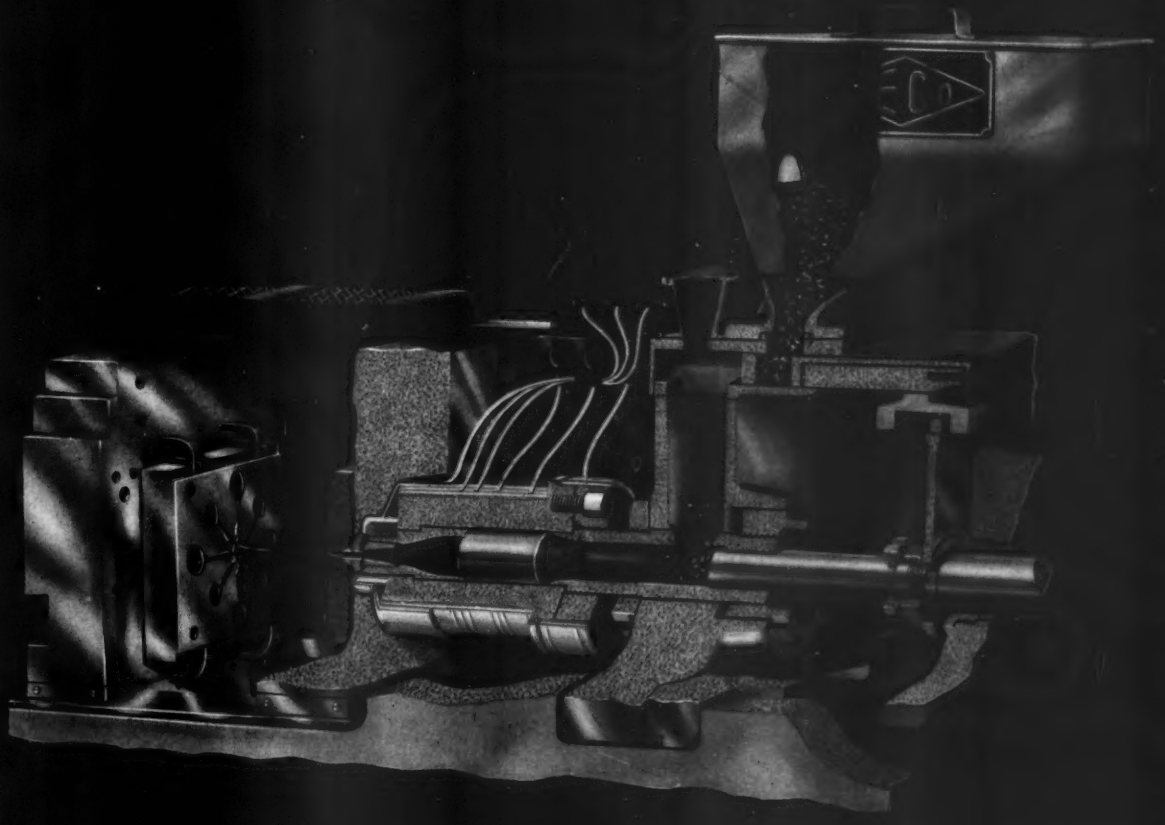

PECO

THE PECO range of Injection Moulding Machines — built to 2 oz., 4 oz., 6 oz., 8 oz. and 16 oz. capacities — are designed to meet the most exacting requirements of Plastics manufacturers, and are in use throughout the world. They are precision machines, giving completely satisfactory output. At the same time, the high plasticising capacity, rate of injection, mould-locking pressure and platen area enable them to be operated at a high rate of production.

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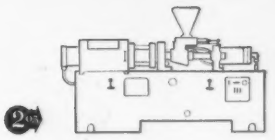
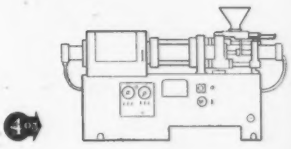
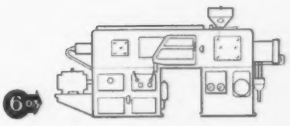
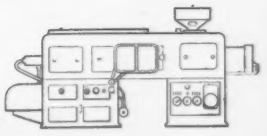
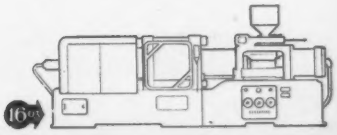
Full particulars of our range of Injection Moulding Machines and Moulds will be sent on request.











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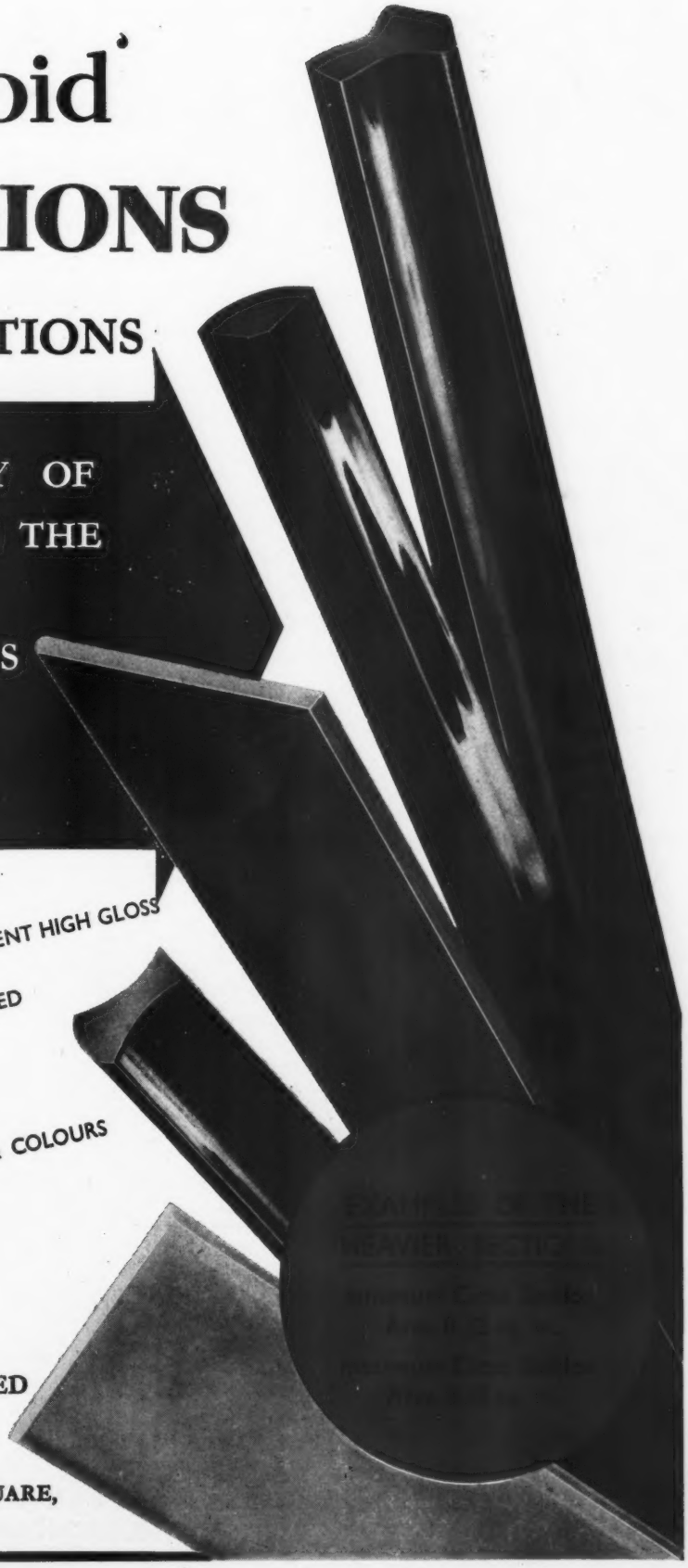

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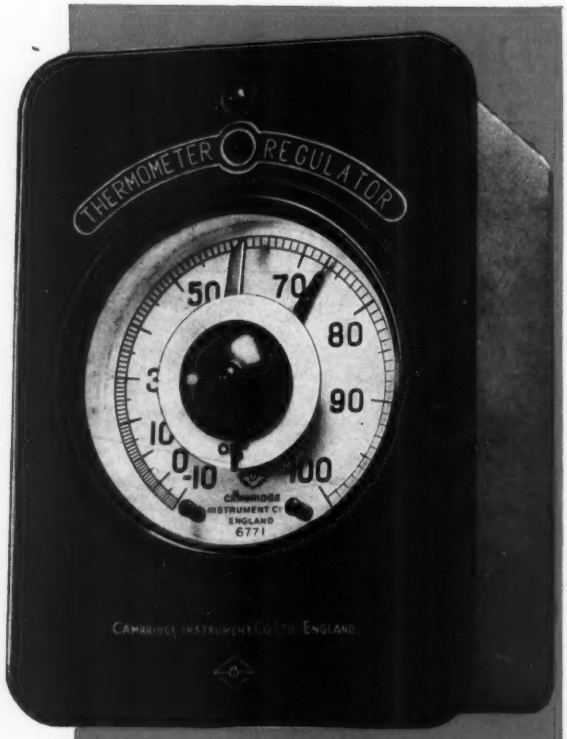

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Plastics

DEALING WITH THE MANUFACTURE, USES AND POTENTIALITIES OF PLASTIC MATERIALS

PROPRIETORS: TEMPLE PRESS LIMITED

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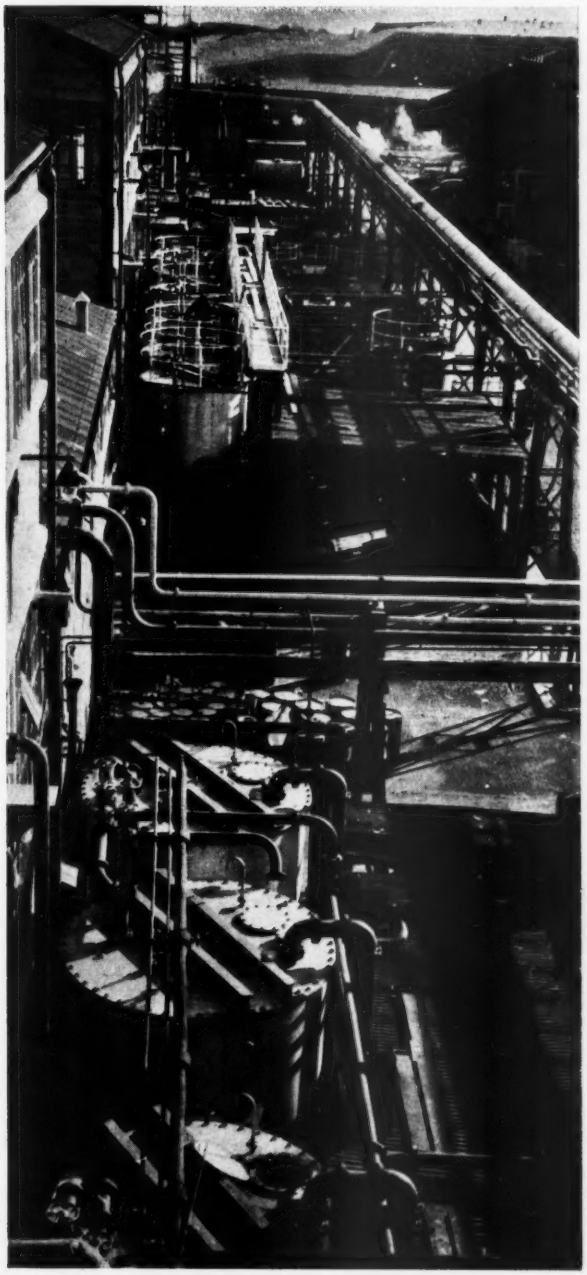

EDITOR: M. D. CURWEN, B.Sc., A.R.I.C.

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Blending tank farm (phenolic and urea resin manufacture) at the works of British Resin Products Ltd., Barry, South Wales.

BMP.9

addition to the family

A new production such as this large washing machine agitator, successfully engineered and made in large quantities, is a satisfactory achievement. To be entrusted with a second similar product, however, is real proof of manufacturing ability.

Both the agitators shown here are made from phenolic plastics by British Moulded Plastics Ltd. at their Walthamstow factory and both the moulds were designed and made at the same works.

The experience that makes achievements of this sort possible is freely available, both at London and Birmingham, to all manufacturers in need of moulded plastics.

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WELbeck 3934

MOULDED PRODUCTS LTD.
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TWO NATIONAL PLASTICS COMPANIES

Plastics

VOL. XVI. No. 173 DECEMBER, 1951

" Gun cotton was discovered in 1845 *and shortly after that date it was found that if the strength of the acids used in its preparation was not properly kept up, an inferior form of gun cotton was produced, which would dissolve in a mixture of alcohol and ether, and that, on allowing the solvents to evaporate, the ' collodion cotton,' as it was termed, was left as a transparent film . . . . Later it was found that collodion cotton could be gelatinised by kneading it with a solution of camphor in alcohol, and then it could be cast or moulded into any desired shape, the alcohol being evaporated, and this was first done by Daniel Spill at works in Hackney, and an excellent imitation of ivory was made which was sold as 'xylonite'."*

Minutes of Proceedings, Departmental Committee appointed to Inquire and Report on Precautions necessary in the use of Celluloid, etc., Home Office, 1912-13, page 87.

EDITORIALS

Saving Scarce Materials

THIS is the title of a recent report published by the Anglo-American Council on Productivity following its visit to the U.S.A. as recently as July, 1951. Some of the references to plastics, their uses and present supply position in the U.S.A., are reported on page 335 of this issue and make interesting reading.

As with almost all the raw materials mentioned in it (it deals preponderantly with metals, especially with those used in making special steels, and with aluminium, copper, zinc and lead), many of the plastics are in short supply with the exception of cellulose acetate and polyvinyl chloride. The most difficult are the phenolic resins, polythene, nylon, polytetrafluorethylene and ethyl cellulose. Also in short supply but less so than the foregoing, are polymethylmethacrylate, polystyrene, melamine, urea resins and cellulose aceto-butyrate. The producing industries, however, are very flexible and, with the exception of the phenolic resin production is expected to expand rapidly. Indeed, the end of the year has already brought us in Great Britain some relief, for supplies of polystyrene and cellulose acetate have already improved.

Before we discuss other aspects of the shortage problem, we should like to refer to the concluding note made in this report, in the last paragraph in the section dealing with plastics: " The general observation must, however, be made that the total tonnage of plastics produced in the U.S. is small in relation to the total tonnage of metals."

It is somewhat startling and disconcerting to find this statement, which has often appeared in print during the past two or three years, repeated by such a body as the Anglo-American Council on Productivity. Obviously plastics production is small compared with that of steel, but it is by no means very small beer compared with the production of aluminium, copper, zinc and lead, which are of major consideration in the Council's thoughts. That it should have thought so (it seems unlikely that the Council is in possession of figures) shows a gap in what should have been part of its equipment.

We have in years past shown such relative productions and have pointed not only to the far greater rate of plastics production with the years, compared with metal production, but have also indicated the importance of considering the production/specific gravity ratio of the comparison. In 1950, this latter comparison was especially stressed by Mr. R. A. Turnbull, of Monsanto Chemical Co. Last month the German " Chemische Industrie " brought the matter up to date with world production figures during 1950. They exclude Soviet production and that of countries within the sphere of Soviet influence.

	Tons.
Plastics	1,350,000
Aluminium	1,600,000
Copper	2,660,000
Zinc	2,080,000
Lead	1,900,000
Total of above metals	8,240,000

Since all the above production of plastics (it does not include synthetic textiles nor surface coatings) is employed in some type of construction and much replaces metal in some form, a more accurate comparison is by volume and not by weight. If this analysis is accordingly made we arrive at the following comparison:—

	Cubic Metres.
Plastics (S.G. 1.2)	1,120,000
Aluminium (S.G. 2.7)	600,000
Copper (S.G. 8.9)	300,000
Zinc (S.G. 7.1)	295,000
Lead (S.G. 11.3)	170,000
Total of above metals	1,365,000

By this means, which we believe to be a not unfair method, the apparently large gap closes rapidly. Since world production in 1951 has already surpassed that of 1950 by at least 20 per cent., we can believe that the gap has already vanished entirely.

Obviously, light weight is not always of value, indeed it can be disadvantageous on occasion, but there is no doubt whatsoever, given the supplies and with proper understanding of the expression " fitness for use " and appropriate study of design and design change, the world will come to regard the low specific gravity of plastics as a property for serious study.

Replacing Metals

THERE is little doubt that the Committee has examined the possibilities of plastic materials in the light of the rearmament programme. Nevertheless this must have been done rather sketchily. It is not only evident in the section devoted to plastics in its very general manner and seems almost the direct result of the " small tonnage " pronouncement " contained in the paragraph mentioned above, but

there are no suggestions as to increasing production similar to those given for metals. One would have hoped that the world phenol situation is of sufficient importance to warrant close examination. The sole comment on the thermosetting resins, both phenolic and urea, is that "it is generally accepted that all defence requirements can be covered by controlling the supply of these plastics for civilian use, the demand for which was likely to be about 80 per cent. higher in 1951 than in 1950. Most of the reduction would be in the production of luxury goods and other articles not entirely necessary in times of emergency." Surely there could be far less possible reduction in this field than in any other of the plastics group since the phenolics are predominantly and increasingly employed in the electrical and other technical fields.

Two important references to plastics are made as growing replacements of metals. The first is in light-duty electrical conductor cables where lead has been effectively replaced by polythene alone or combined with aluminium or steel. Three new developments are (a) Replacement of lead sheath by one of corrugated aluminium covered by polybutene and polyethylene; (b) an outer lead sheath of reduced thickness over polythene insulation; (c) a similar combination using steel in place of lead. The second reference is to "the replacement of zinc die-castings by plastics, a type of substitution which has been more favoured by the radio industry." The matter of replacing zinc die-castings has indeed grown steadily since the beginning of the past war and was discussed in some detail in the May, 1939, issue of "Plastics."

Moulding Powder and Shot

Here is what seems to be an appropriate use of plastics in replacing a traditional material, from many points of view—high strength, resistance to atmospheric conditions, lack of bulk and the use of a home-made product, thus avoiding employment of imported cotton. The strange objects in the photograph are the "mechanisms" for opening and shutting and supporting the aluminium slats of the new type Venetian blinds that are now so widely used in countries that are lucky enough to have the sun shining on them. The one on the

Venetian Serenade

left is of traditional "duck," while the other is of woven nylon which replaces it. The individual slats rest on the cross members of the "ladder" which is tugged to open or shut them. The "duck" is, of course, liable to rot.

* * *

November 1. This night, to Thames Side, in Bridge Ward, invited by the Clerk of the ancient Worshipful Company of Horners to the Fishmongers Halle; there to dine; the said Company being with no Halle of their own since these many yeres. Thus to London Bridge and was received most cordially by the Clerk, Thom. Clarke; I do find him a very pretty and most able person, a man of very fine parts and of infinite zeal, as a Clerk should be. So into the Halle, wich was mighty full and graciously welcomed by the Master and Wardens. Thereafter found myself among more friends, many makers of the new plasticks, to wit, Cyr. Dingley of the Oxford Road, Ch. Waghorne come special from his countrye place at Waltham Stowe, Cyr. Last now back from his most recent travel to Byrminghame, Dav. Evans of Carshaltonne in the countie of Surrey with his excellent and worthy Father, Will. Diamond from his office of the Covenanters of the Plasticks Industrie off of Pick-a-dilly and last but not the least, as will hereafter be noted, Arch. Renfrew, a Scotchman come long to this countrye and employed in the village of Welwyne. The whole assembled, after asking God's Grace, then sat down to a noble dinner of soupe and delicate fishe and good game and sweet meats. And here drank most excellent and great variety and plenty of wines, more than I have drunk at once in these seven yeres, but yet did me no hurt. Then to listen to a very learned discourse yet full of good humor and miraculously short, from Arch. Renfrew the Scotchman, on new fibrous materials and fabricks; wich he told were made from black coale and stone-oyle; wich amazed the companye mightily and me, who considers too much of misterie and magick therein. Methought I shall not believe this till Arch. Renfrew send me a night shirt made thereof. Then followed in graceful speech by the Master, of thanks to him for his discourse; well deserved, and by others in great merriment. Now I must tell of the antiquity of the fraternity of Horners which was incorporated by Letters Patent of the Thirteenth of Charles the First anno 1638 under the appellation of The Master, Wardens, Assistants and Commonalty of the Art and Mistery of Horners of the City of London. In the reign of Edward the Fourth this Fraternity was reduced to great Streights by the almost general exportation of Horns and on application to Parliament in 1465 this was stopped. As is further writ, the Company for the more effectual preventing Monopolies, and the evil designs of sinister men, did appoint divers of their Members to attend the Markets for the buying of Horns; whence they were sent to their common Warehouse in Wentworth Street, Spittlefields, where they were divided by lots among the several Members of the Company; whereby all Frauds and Impositions were happily prevented, to the great Ease and Advantage both of Widows and Orphans who received their several Shares in proportion with other Members. So much for Historie. To-day it doth appear that the Company of Horners do support mightily in spirit and in deed the industrie of Plasticks; which is the direct descendant of the ancient craft of the working of horn into drinking vessels, windows, combs, armour and divers other objects of commerce. So it is good to record that this yere the Companye had offered noble prizes of 50 *l.* and 15 *l.* to the young apprentices and craftmen in the Plasticks industrie for new designs of useful things both appropriate in use and pleasing to the discerning eye. Thus it was that Cyr. Dingley, representing the Plasticks manufacturers, rose and spoke of this and the magnanimity of the Master Wardens and Liverymen; and he gave the moneys there to two young craftsmen for the excellence of their works in this respect, amid great acclaim. I saw no gold pass, however, but two Pieces of Paper writ with promises of payment of the said 50 *l.* and 15 *l.* wich to me seemed strange; but withal do presume is O.K. Then more wines and did drink also, as did all assembled and separately from a loving Cup from a great Horn according to ancient custom these many hundred yeres. So left; full of good cheer and right merrie; and so to Bed.

Peeps intoe Tradicion

DOGSBODDY.

Plastics Shortages in the United States

Report of the Anglo-American Council on Productivity

THE Anglo-American Council on Productivity, which was formed in the autumn of 1948 to promote economic well-being by a free exchange of knowledge in the realm of industrial organization, method and technique, and thereby assist British industry to raise the level of its productivity, has just issued a report on "Saving Scarce Materials." This report, which follows the visit of a specialist team to the United States in June and July, 1951, concerns itself chiefly with the metals situation, but also includes a section devoted to plastics.

In their various interviews, the team found no unanimity of opinion about shortages of plastics, and there seemed to be considerable uncertainty about the immediate and future supply situation. They group the varying degrees of shortage as follows:—

Group I (in very short supply)

Ethyl cellulose.	Phenolic resins.
Nylon plastic.	Polyethylene.
Polyvinyl alcohol.	Polytetrafluorethylene.
Polyvinyl acetate.	Resorcinol resins.

Group II (in tight supply)

Alkyds.	Pliofilm.
Cellophane.	Polyesters.
Cellulose butyrate.	Polystyrene.
Melamine.	Polyvinyl butyral.
Methyl methacrylate.	Polyvinylidene chloride.
	Urea resins.

Group III (in fair supply)

Cellulose acetate.	Polyvinyl chloride.

It will be seen that only cellulose acetate and polyvinyl chloride are shown as being in fair supply.

The use of plastics as alternatives for non-ferrous and other metals was widely discussed. For technical and supply reasons it was generally considered that plastics could not be automatically used in place of metals although there were many applications where they were more effective owing to such properties as lightness or ease of production.

One outstanding substitution considered was the use of plastics in place of zinc alloy die-castings, which are in critically short supply owing to scarcity of zinc. Many examples of this kind were quoted, but the general reservation must be made that such changes can only be achieved after careful consideration and redesign of the component which is to be replaced. Plastics can be metal-sprayed and coloured and this property is being used in decorative applications.

Dealing with the two classes of plastics —thermosetting materials and thermoplastic materials—the position is as follows—

Thermosetting Materials

(1) PHENOL-FORMALDEHYDE AND (2) UREA-FORMALDEHYDE.—It is generally accepted that all the defence requirements can be covered by controlling the supply of these plastics for civilian uses, the demand for which was likely to be about 80 per cent. higher in 1951 than in 1950. Most of the reduction would be in the production of luxury goods and other articles not entirely necessary in times of emergency.

Thermoplastic Materials

(1) POLYSTYRENE.—Owing to its excellent dielectric properties, together with its resistance to water and certain acids, polystyrene is a most popular plastic material for a great many uses and will be in demand for the defence programme. Polystyrene was classified as "in tight supply" in the U.S., but with normal care in its use there should be sufficient for essential civilian and defence needs. Certain expansions in its production had already been made or were in the process of being completed.

(2) METHYL METHACRYLATE ("PERSPEX").—No present difficulty is envisaged in the supply of this material for defence purposes in the U.S. Nevertheless, the present indication on the U.S. Government list is Group II (tight supply).

(3) POLYTHENE ("ALKATHENE").—This is a very useful plastic because of its low-loss characteristics at high frequencies, its resistance to water and certain chemicals and its absence of brittleness at low temperature. It is, however, affected by petroleum. Extrusion properties are good, making it suitable for a wide variety of uses as a substitute for metallic piping provided the fluid passing through it does not have a temperature exceeding 212 degrees F. (100 degrees C.).

Polythene is widely used in the electrical industry, especially for radio and radar applications. It has also an extensive use in consumer goods, especially for its decorative properties.

Again no difficulty is expected about the use of this material for authorized defence purposes.

(4) POLYVINYL CHLORIDE (P.V.C.).—This material is not affected by petroleum, although the same temperature restriction applies as in the case of polythene. It is often used for the covering of electric cable as a substitute for rubber, to which it has a close resemblance in appearance. It is also resistant to water and weak acids.

(5) NYLON.—Nylon is being used for a wide variety of engineering purposes such as lightly loaded bearings and instrument gear wheels. It is a fairly inert material, is not affected by petroleum, and therefore can be used where petroleum and its products, e.g., lubricating oil, are involved.

(6) CELLULOSE ACETATE.—This is a plastic with moderate dielectric properties and is used for various electrical components as well as in other industries. It must not be used at high temperatures as softening is likely to occur at temperatures above 140 degrees F. (60 degrees C.). It is resistant to most mineral and vegetable oils, but not to acids and alkalis, and tends to absorb moisture. The team did not find that there was any anxiety about the supply of cellulose acetate as at the moment the bulk of the material is used for civilian purposes and in the manufacture of luxury goods.

LAMINATED PLASTICS.—These are used quite extensively in the U.S., especially where greater strength is necessary. There are various types according to the materials used in their production.

General Observations

Only a few uses of plastics have been mentioned as direct conservation measures. Numerous other examples which were shown or described to the team are already familiar to British industry. These include bearings, gear wheels, piping, lining of vessels, and a wide range of electrical uses. The general observation must, however, be made that the total tonnage of plastics produced in the U.S. is small in relation to the total tonnage of metals.

Books Received

"Plastics and Building." By E. F. MacTaggart and H. H. Chambers. London: Sir Isaac Pitman and Son, Ltd. 60s.

"An Introduction to the Chemistry of the Silicones." By Eugene G. Rochow. New York: Wiley and Sons, Inc.; London: Chapman and Hall, Ltd. 40s.

"Modern Plastics Encyclopedia and Engineer's Handbook." New York: Plastics Catalogue Corporation. 18s.

"Australian Plastics Yearbook 1951." Sydney: Australian Trade Publications Pty., Ltd. 25s. (Aust.).

"Kunststoffe in Deutschland—Erzeugung, Verarbeitung, Verwendung" ("Plastics in Germany—Manufacture, Processing, Application.") Special October, 1951, issue of "Chemische Industrie." Düsseldorf: Verlag Handelsblatt G.m.b.H. 20s. (U.K. price).

"Synthetic Resins and Allied Plastics." Ed. R. S. Morrell. Third edition edited by H. M. Langton. Oxford University Press. London: Geoffrey Cumberlege. 50s.

"Plastics Progress: Papers and Discussions at British Plastics Convention." Iliffe and Sons, Ltd. 50s.

"F.B.I. Register of British Manufacturers" 1951/1952. London: Kelly's Directories, Ltd., and Iliffe and Sons, Ltd. 42s.

Potted Electronic Circuits

By E. N. SHAW, H. G. MANFIELD and K. ATKINSON*

ELECTRONIC equipment plays a vital part in modern aircraft and its design must meet exacting requirements. The high speeds achieved in the air to-day call for increased rigidity and freedom from vibration. Electronic assemblies must also be able to withstand high accelerating forces, changes in pressure and climate and long periods in storage, often under adverse conditions. In addition, these qualities must be achieved without increase in size and weight; "miniaturisation" is, in fact, an important aim in itself.

"Potted circuits" in which electronic components after assembly are embedded in resin, on the well-known "flies in amber" principle, provide one answer to these problems. A team of workers at the Ministry of Supply's Telecommunications Research Department, headed by E. N. Shaw, has been working on these for the past two years, using the polyester resins manufactured by Scott, Bader and Co., Ltd., under the trade-name "Marco," in particular the variety known as "Marco 28c." The fruits of their work have been displayed this year at several exhibitions. "Potted circuits" shown at the Society of British Aircraft Constructors Exhibition and elsewhere have demonstrated the advantages of the method, in particular, the extreme miniaturisation achieved, one assembly having no less than 38 components embedded in a block of resin measuring 2¾ in. by 1¾ in. by 11/16 in.

The great advantage of "Marco" resins in this work is due to the simplicity with which potted assemblies can be produced. The resins are obtained in the form of thin syrupy liquids. They polymerize when mixed with a catalyst (either benzoyl peroxide or 1-hydroxycyclohexyl-hydroperoxide-1), and the reaction may be speeded up by the inclusion of an accelerator based on cobalt naphthenate. The production process, basically, is merely the pouring of the mixed fluids into a simple mould, which is then either put aside to "gell" at room temperature or cured in an oven for a few hours.

No great capital outlay is required for moulding tools or heated presses. This economy in production overcomes to a great extent the main disadvantages of potted circuits—the fact that the final assemblies are "throw-away" units, to be discarded when faulty, since internal alterations are impossible after the casting process. "Throw-away" units in any case, have their own economies, such as simplification of storage and maintenance by unskilled labour.

* Ministry of Supply, Telecommunications Research Establishment.

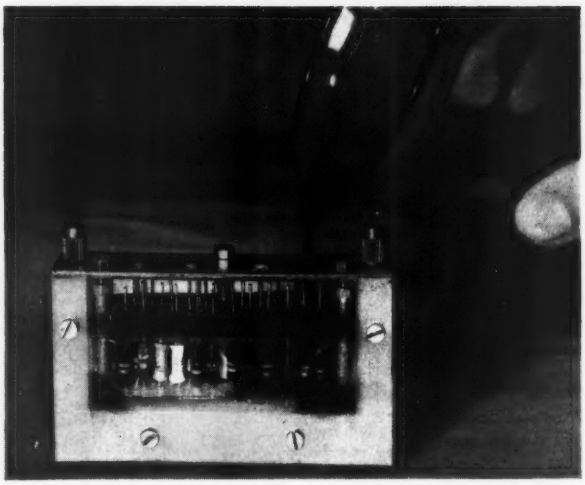


Fig. 1.—Pouring "Marco" resin into the mould in making a "potted" electronic circuit. The mould is of polythene and "Perspex," the latter being covered with "Cellophane" tape to prevent adhesion of the casting resin.

Preparation of Assemblies

These factors influence the design of the assembly to be potted. Contrary to American practice, for example, workers at the Telecommunications Research Establishment prefer to mount valves, which are comparatively costly components, outside the cast assembly, so that they need not be discarded should other components fail. (Outside mounting also prevents unduly heavy thermal loads on the resin, which may have an adverse effect on the performance and life of the other components.)

The moulds used for potting can be constructed of any one of a number of materials, tin-plate being an obvious choice. Certain substances, copper and phenol among them, partly or completely inhibit the curing of the resin. Even these can be used, however, if they are first coated with material sympathetic to the resin.

If the mould is made of metal, some form of releasing agent will be necessary, carnauba wax dissolved in carbon tetrachloride being suitable. When a material incompatible with the resin is used, no release agent is necessary; such materials are, polythene, polyvinyl chloride and "Cellophane." The inclusion of an inorganic filler with the resin reduces its tendency to stick to the mould.

The components to be potted are first assembled between thin wafers of "Perspex." Tubular brass inserts, which fit over studs in the base of the mould to hold the assembly in position, also pass through these wafers. The edges of the wafers are scalloped to allow the escape of air trapped below the horizontal surfaces as the resin is poured in.

Table I.—Properties of Marco S.B.28c Resin with Various Fillers

Filler	Coefficient of Linear Expansion (at 60°C) × 10^{-6}	Thermal Conductivity (watts per sq. in. per °C per inch)	Water Absorption (milligrams)	Specific Gravity	Compressive Strength (lb. per sq. in.)	Tensile Strength (lb. per sq. in.)	Brinell Hardness (500 kg. load 10 mm. ball)	Dielectric Strength (volts per mil.)	Power Factor tan δ 1 Mc/S to 100 Mc/S	Dielectric Constant 1 Mc/S to 100 Mc/S
Unloaded ..	97	0.0065	50	1.23	18,000	7,000	49	250-300	0.018—0.016	3.3 —3.1
Mica	65	0.0074	50	1.38	19,600	5,000	49	400	0.0213—0.0176	3.62—3.44
Glass	70	0.0073	40	1.55	25,000	5,000	49	380	0.0165—0.0160	4.53—4.25
Alumina ..	70.5	0.0109	60	1.87	26,600	3,700	76	270	0.0194—0.0177	5.05—4.8
Calcium carbonate	84	0.0069	50	1.5	18,500	4,250	65	280	0.0173—0.0164	4.75—4.51

Fillers

Cracking of the cast block due to differential expansion between the resin and the components can be prevented by loading the resin before casting with a filler (in common with all plastics, casting resins have a high coefficient of linear expansion, sometimes as much as four to five times that of brass).

Experiments have been carried out at the Telecommunications Research Establishment using mica, glass, alumina and calcium carbonate. Sample castings loaded with each material to ascertain their various properties produced the

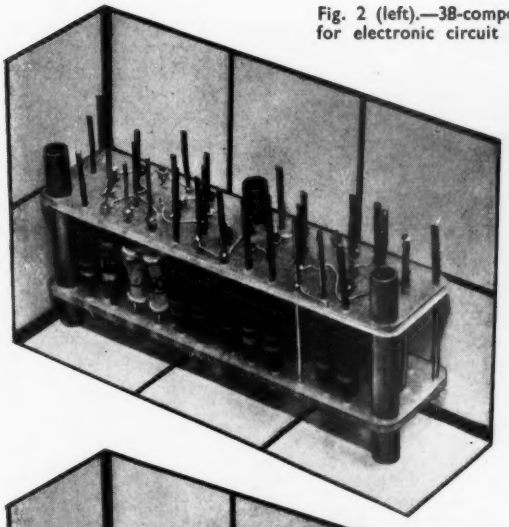


Fig. 2 (left).—38-component assembly for electronic circuit before casting.

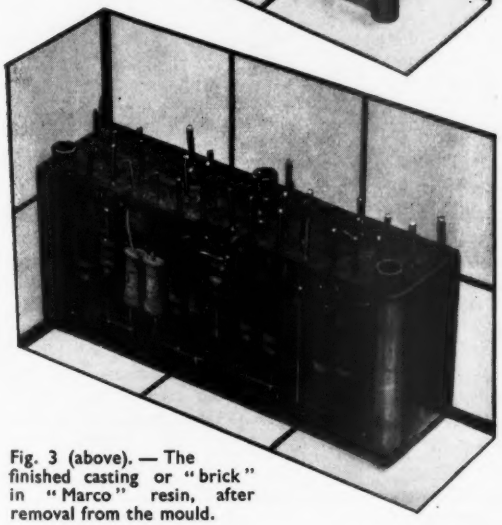


Fig. 3 (above). — The finished casting or "brick" in "Marco" resin, after removal from the mould.

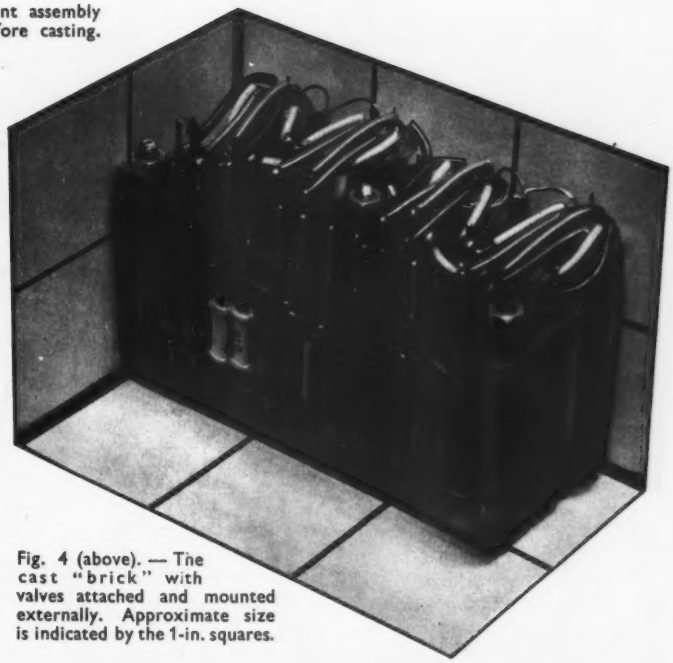


Fig. 4 (above). — The cast "brick" with valves attached and mounted externally. Approximate size is indicated by the 1-in. squares.

results tabulated in Table 1. An analysis of these figures and subsequent experience has proved that glass or mica are the most suitable fillers for potted circuits.

Effects of Catalyst and Accelerator

The time needed for the polymerization cycle can be varied from a few minutes to several hours by altering the proportions of catalyst and accelerator. This also affects the degree of hardness and the colour of the final casting. Careful control by these means can also reduce the heat produced during the reaction—which may otherwise reach temperatures as high as 150 degrees C.—to a level only slightly above room temperature.

Experiments carried out at the Telecommunications Research Establishment, show that a mixture of "Marco 28c" with 4 per cent. catalyst and 4 per cent. accelerator, has a gelling time of 20 minutes, the maximum temperature reaching over 130 degrees C. Reducing the amounts of catalyst and accelerator to 3 per cent. lengthens the gelling time to 35 minutes and reduces the maximum temperature to just over 120 degrees C. With 2 per cent. catalyst and 2 per cent. accelerator, the maximum temperature is under 100 degrees C., with a gelling time of 40 minutes. With 1 per cent. catalyst and 1 per cent. accelerator the maximum temperature is under 30 degrees C. and the gelling time is about three hours.

The mould and assembly having been set up, the appropriate quantity of casting resin (one pound makes about 20 cubic ins. when cast) is measured out, catalyst and accelerator are added, and the three components are thoroughly mixed together. If a filler is to be used, it is added at this point and well stirred in, then allowed to stand for a short time to disperse the air bubbles, this is best done under reduced pressure. When it is required to reduce the viscosity of the resin, which may be essential when the assembly has many blind corners and pockets, monomeric styrene may be added in small quantities. As soon as possible, the mixture is poured into the mould, which is tilted where necessary to enable the resin to penetrate pockets and crevices.

The casting is usually cured at room temperature, but the reaction may be speeded by placing the mould in an oven at a temperature between 30 degrees and 50 degrees C. This is essential where the ratio of the volume of resin to the mould and components is low. The geometry of the assembly is sometimes such that the relative conductivity and thermal capacity of the metal mould is so great that the heat of the reaction process is conducted away before it can effect polymerization.

Polymerization completed, the assembly is removed from the mould. Full curing may take several weeks, but the process can be hastened by artificial ageing in an oven, three or four hours at 50-60 degrees C. is usually sufficient.

The results of a considerable volume of work carried out at the Telecommunications Research Establishment on potted circuits are outlined in Ministry of Supply publications:—

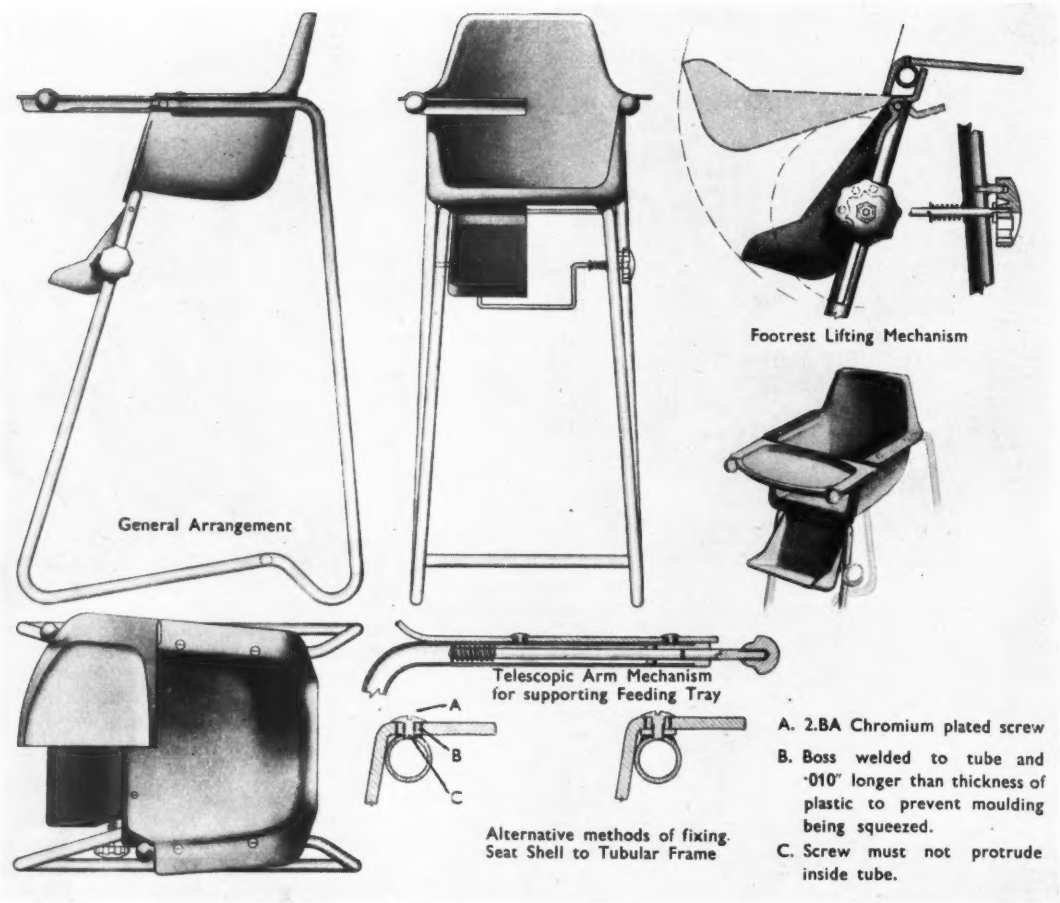
E. N. Shaw, "Cold Casting as a Constructional Technique for Sub-miniature Electronic Assemblies." (T.R.E. Technical Note No. 90.)

H. G. Manfield, "Casting Resin Techniques for Potted Circuits." (T.R.E. Technical Note No. 145.)

New Research Foundation

AN international industrial research organization, to be known as the Battelle International Institute, serving European industry on a non-profit basis, will shortly be established in Europe by the Battelle Institute, Columbus, Ohio, U.S.A.

The new organization will establish research investigations in existing research institutes of Europe, and in European universities and technical schools. It will also operate its own laboratories on the Continent, the exact locations of which will depend upon the outcome of negotiations which are now in progress. As with the parent organization, financial support for these activities will be derived from industrial sponsorship, from endowment, and from the income from patents which are owned by Battelle.


General Arrangement
Footrest Lifting Mechanism
Telescopic Arm Mechanism for supporting Feeding Tray
A
B
C
Alternative methods of fixing Seat Shell to Tubular Frame
A. 2.BA Chromium plated screw
B. Boss welded to tube and ·010" longer than thickness of plastic to prevent moulding being squeezed.
C. Screw must not protrude inside tube.

Horners' Awards 1951 : First prize, design for child's high chair, (Mr. A. H. Woodfull, of British Industrial Plastics, Ltd.)

Horners' Awards, 1951

THE ancient craft of producing from horn many domestic and utilitarian items has a link with the newer industry of plastics, and the Worshipful Company of Horners makes an annual award for the best design in plastics in accordance with conditions laid down. Eight entries were sent in this year, but only four of these fully complied with the conditions.

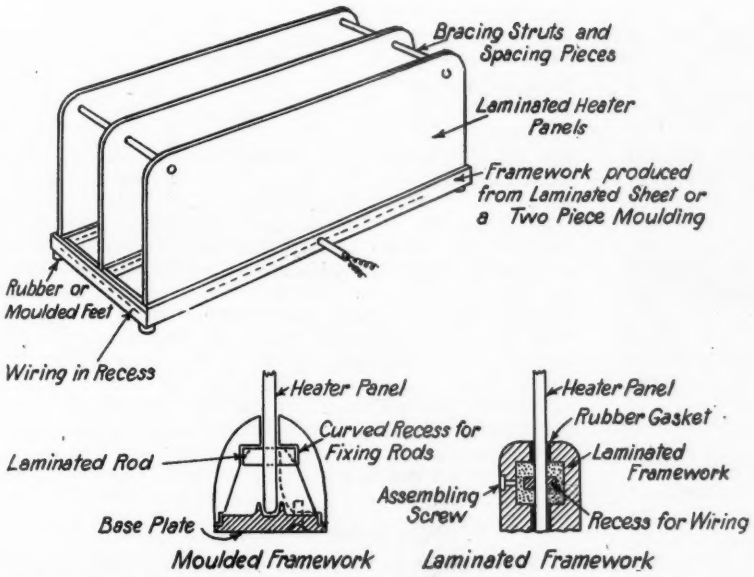
The award of first prize (£50) in the 1951 competition has been won by Mr. A. H. Woodfull, head designer of the Product Design Unit, British Industrial Plastics, Ltd., and secretary of the Midland Industrial Designers' Association; his prizewinning design is for a child's high chair, made from moulded plastics and tubular metal.

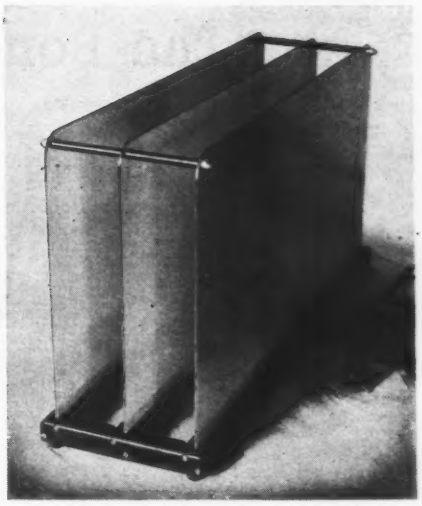
This chair is moulded in sympathy with the natural shape of a child's body and carries a footrest adjustable for angle, as the child grows. Most important, perhaps, is its hygienic nature. All germ-collecting corners, cracks and crevices have been eliminated, and the chair can easily be cleaned by wiping with a damp cloth. The easily-removable tray is of special stain- and heat-resisting material. It clamps firmly to the chair by spring-loaded telescopic arms, which retract into the tubular structure when the tray is not in use. The chair can safely be tipped up to 30 degrees without overturning.

It is proposed to use "Beetle" urea for the moulded parts of the actual chair, footrest and knobs, because of the wide range of colours available; melamine would be used for the tray, on account of the excellent resistance offered against staining and hot water. The seat would be moulded in a semi-positive two-plate mould, requiring approximately 750 tons moulding pressure. The footrest would need approximately 200 tons pressure, using a similar type of mould. In the case of both components, the form would be tipped to about 45 degrees to the die block; it is thus placed to avoid sheer faces between punch and die and to assist even flow of material.

The design was evolved after very careful consideration of existing types of

The moulded parts of this chair are in "Beetle" urea and melamine ; the framework is tubular metal.





Horners' Awards, 1951: Second prize, design for napkin dryer and airer (Mr. J. T. Maddison, of Bakelite, Ltd.).

similar chairs. It breaks new ground not only in the employment of plastics material for the main components, but in its overall conception as a modern, essentially practical, article of nursery furniture.

The second prize (£15) has been awarded to Mr. J. T. Maddison, of Bakelite, Ltd., for the design of a napkin dryer and airer.

This dryer consists fundamentally of a series of laminated heater panels designed to work at a temperature of about 70 degrees C. and mounted in a frame in which all the electrical wiring is recessed. The heater panels are of general-purpose paper-base laminated sheet about $\frac{1}{8}$ in. thick and measure 26 ins. by 14 ins., with the heating element moulded in at the centre and disposed to cover an area of $24\frac{1}{2}$ ins. by 12 ins. The panels may be produced with either natural, brown, black, wood-grained, or, in special circumstances, certain more decorative finishes.

In producing small quantities, the mounting frame would be produced by fabrication from a general-purpose paper-base laminated sheet, but for quantities sufficient to merit the cost of moulds the frame could be produced as two mouldings—a mounting frame and a base plate. The model submitted was constructed with laminated sheet.

The advantages of this dryer are that it is safe from an electrical viewpoint; it is clean and hygienic, and napkins may be left on it for an indefinite period without fear of scorching or deterioration.

LETTERS TO THE EDITOR

Cementing Thermoplastics

Sir,—I found quite an amount of useful information in the first article on the "Cementing of Thermoplastic Mouldings" in your October, 1951, issue. There was not, however, any information on a problem which has been worrying me for some time, i.e., the joining of a cellulose acetate-butyrate moulding to a polystyrene moulding. Whilst the obvious solution to the problem is to use a similar material for each moulding, the shortness of supply of the butyrate makes this impossible. The problem therefore remains as follows:—To stick a glass-clear polystyrene scale into a coloured cellulose acetate-butyrate cabinet. The solvent to be applied by pencil brush to the joint made by clamping the scale to the cabinet with the aid of two small spring clamps.

K.R.

Educational Collection of Plastics

Sir,—We were interested to read in the November issue of "Plastics" a description of the educational set put out by the Plastics Research Institute T.N.O., at Delft, Holland. This strikes us as being an extremely interesting idea, particularly as several of our buyers purchase plastics in one form or another, and this outfit would be an extremely useful practical reference. Could you please tell us whether this set is available in this country, or alternatively, where we could purchase it and approximately how much it would cost? It is assumed that the printed matter would be in English as well as Dutch.

THOMAS HEDLEY AND CO., LTD.
Phœnix Buildings,
Newcastle upon Tyne, 1.

Polythene Hose

Sir,—Could you let me have the address of firms that manufacture hose in polythene? The names of their respective representatives on the Continent of Europe would also be welcomed.

Spalenberg, 10, PETER KOCH.
Basle, Switzerland.

[EDITOR'S NOTE: Manufacturers of extruded hose pipe from polythene include Tenaplas, Ltd., Upper Basildon, near Pangbourne, Berks; I.C.I., Ltd., Plastics Division, Welwyn Garden City, Herts; Melwood Thermoplastics, Ltd., Willoughby Road, Harpenden, Herts.]

Cellulose Wadding

Sir,—Kindly let us know the names of U.K. manufacturers of cellulose wadding.

NEW HYGIENE, LTD.
266-268, Holloway Road, N.7.

[EDITOR'S NOTE: James R. Crompton and Bros., Ltd., Elton Mills, Bury, Lancs; New Waterside Paper Mills, Ltd., Grimshaw Bridge Works, Eccleshill, Lancs; St. Andrew's Mills, Ltd., 34, St. Andrew's Road, Walthamstow, E.17; Robinson and Son, Ltd., Wheatbridge Mills, Chesterfield.]

Tooth-brush Containers

Sir,—We have an inquiry for regular orders of transparent plastic tooth-brush containers, amounting to 400 gross each, from one of our Far Eastern customers.

M. D. EWART AND CO., LTD.
52, Princess Street,
Manchester, 1.

Pulverized Wool Waste

Sir,—We are producers of a pulverized wool waste which we believe can be employed in certain processes in the plastics industry. We should like to get in touch with any likely concerns to whom this material may be of interest.

D. JACOBSON AND CO., LTD.
152 Sunbridge Road, Bradford.

The Bonding of Friction Fabric

By G. S. LEARMONTH*

THE bonding of friction fabrics to their metallic supports is one of the latest developments in the use of organic synthetic materials to replace more orthodox methods of fastening. The process owes its success mainly to developments in the use of these adhesives during the past war, chiefly in connection with the aircraft industry. There is no theory involved which does not already apply in the normal bonding of metals to any organic (wooden or plastics) material (i.e., one porous and one non-porous surface). This means that the bond will be a combination of mechanical and specific adhesion on one side, and of specific adhesion only on the other.

Brake and Clutch Facings

Nearly all brake linings are composed of asbestos fibres bonded together with a resinous, oil-based, bituminous or rubberized medium. In order to obtain the correct coefficient of friction and durability the amount of the binder is strictly limited in that it forms in the neighbourhood of 30 per cent. of the finished product. The asbestos may be used in one of two forms; as long fibres spun into heavy yarns and woven into thick fabrics; or short fibres in random assembly.

The cloths used, in the first method, may be either about $\frac{1}{16}$ in. thick (1½ mm.) and built up into the finished article by laminating under the influence of heat and pressure, or, alternatively, may be solid-woven, up to 1 in. thick, and processed by impregnation and subsequent consolidation under heat and pressure, and sometimes in addition by a baking process.

It has for some years been common practice to use the second method in the United States and in this country; this method employs asbestos incorporated with a binder, either in the dry state or dispersed in solvents or water, which is formed by moulding, extruding, sheeting, etc. Sometimes the asbestos fibres are previously formed into sheets of "millboard."

For woven brake linings the binding medium may consist of phenol or cresol formaldehyde single-stage resins, or more frequently of a composite varnish which may contain one or more of the following materials: oil-modified resins, vegetable oils, bitumens and natural resins.

Moulded materials may contain phenolic single or two-stage resins (occasionally oil-modified), cardolite products, rubbers and oils. Other materials may be added to the moulded products, usually in the nature of powdered fillers in order to achieve certain desired effects, but these do not normally appear to affect the bonding process in any way.

All friction fabrics are distinguished by the possession of a resinous skin, i.e., the surface layers are richer in organic binder content than the interior; this is, of course, true more or less of all plastic mouldings, but the woven asbestos products are particularly troublesome in this respect. The working surface is always ground off or otherwise removed by machining, but the back, which is, of course, the surface used in bonding, is normally left more or less untouched. With all moulding processes this skin is thin and readily removed, but the woven ones are often not only highly rich in organic matter but very rough owing to the coarse weave used, and special preparation for bonding is necessary.

The duty expected of friction fabrics varies enormously according to the machine to which the brakes are attached. The lightest duty of all is probably found in cycle and autocycle linings which are very small and operate at low speeds and under light pressure. In automotive work the range starts from the average light car where the braking loads are quite small, and the temperature reached is low. It has been found by experiment that the difference of temperature between the working face and the bonded back surface may be only some 10 degrees C. at a working temperature of 110 degrees C. The next heavier duty is found in such commercial vehicles as trucks and lorries. In the heaviest duty the working face of the brake may reach 300-350 degrees C, or even higher. Properly designed and operated clutch facings, however, do not generally have to operate under such arduous conditions and very high temperatures are unusual. The chief element destructive to the bond in all these applications is the heat generated; when properly applied, the shear loads met with are well within the capacity of the adhesives used.

History of the Subject

Although bonding of friction fabrics is of recent development, and has only been carried out commercially since about 1947, it originated some years ago. British Patent 36564, granted to an American citizen in 1930, apparently considered the use of a natural rubber composition as a bonding agent, and at the same time as a cushion between the lining and the shoe. More recently British Patent 617766 describes the injection moulding of brake linings directly on to a shoe which has been pre-coated with adhesive, and a further one of more importance covers the use of an adhesive in strip form in which the base is "a network of cellulose fibres .001-.005 in. thick with the object of providing for easier removal of the old lining.

In the period from 1935 to 1940 important developments were taking place with thermosetting synthetic adhesives with the object of securing efficient adhesion to metals and these were forced to early fruition by the war-time conditions which followed. In the aircraft industry particularly it was found possible in many cases to eliminate riveting and to replace it by synthetic resin bonds which were not only as good as the riveted joints, but had certain specific advantages, for example, the slight degree of resilience in the resinous bond was found to give better resistance to vibration.

Work on the bonding of brake linings to shoes started in earnest in the U.S.A. in 1934 and the project was carried at this time to the stage of development where a satisfactory synthetic rubber-resin bonding agent was evolved. The linings were cured by R.F. heating procedure in some 2 mins. and were found to give approximately twice the life of the riveted assembly on the dynamometer. The same method was then applied to wheel brakes, and at the same time improved adhesives were tested with good results both on the testing machine and on the road. War-time conditions then caused this investigation to be held over until 1945, when Buna N-phenolic resin adhesives were used and R.F. heating was abandoned in favour of oven curing, and later the so-called "hot-shot" process was developed.

During the same period the first recorded British applications of the bonding process used were made. Some difficulty was experienced with the clutch assemblies of certain tanks due to separation of the friction facing from the metal backing plate, and it was found that considerably better results were obtained by using "Redux" to bond the two together. It was found that the riveted discs disintegrated at about 5,000 r.p.m. whereas bonded discs could be run at over 6,400 r.p.m. without apparent harm resulting. The service life of the riveted joint was some 200 hours while a bonded one operated for over 2,000 hours. In addition, when a disc

* Chief Chemist, Gandy, Ltd. Extracted from one of the lectures delivered at the recent Special Summer School on technical applications of synthetic resin adhesives, by kind permission of Aero Research, Ltd.

was run to destruction the steel disc broke and the bond remained intact.

Adhesives for the cementing of metals to metals or to organic materials, commonly consist of a phenolic resin modified by the addition of a thermoplastic material such as a vinyl derivative or a synthetic elastomer. In some cases also a synthetic rubber may be used with another type of resin, and the bond stabilized by vulcanizing the rubber. The adhesives found suitable for the bonding of friction fabrics have been of these types.

Without going deeply into the theory of adhesion it may be assumed that the function of an adhesive in a join is a combination of " sticking " and " load transmitting " and that except in very thin layers of adhesive the strongest part is immediately adjacent to the surface while in the centre of the adhesive, random orientation will occur. When an insoluble thermoplastic material is added to the adhesive, it acts as a filler whose particles are of molecular dimensions and the strength of the whole bond is high, comparable with that of the surface layers. In addition a certain amount of cross linking will occur between the thermoplastic material and the resin.

The adhesives are prepared and marketed in three forms:—

(1) As solutions in volatile solvents. These are applied to metal and fabric surfaces, the solvent removed, and the two then united. In this form the usable life is about 3 months or less.

(2) As precemented liners. These start as in (1) and in general the cemented liners will be available from the assembly lines manufacturer of the lining or brake. The life is about 12 months.

(3) As precemented tape. This tape may be made of various materials, such as kraft paper, the absorbent bases being impregnated.

In all cases once the solvent has been removed from the adhesive the process is virtually the same.

The process with which the author has carried out most work is of the " Redux " type. This is of the type comprising a phenolic resin modified with a polyvinyl formal. Normally, the resin is supplied in solution in meths and the polyvinyl formal separately as a granular powder. The two are mixed in the application process and mutually dissolve when the bond is heated. It can also be used by both the tape and the precemented liner process.

Experimental Results

All woven linings are rather erratic in behaviour and, due to the type of impregnant used, are greatly weakened at the highest temperatures. Considerable fluctuations have also been observed from time to time with woven linings owing to variations in the degree of bake, in resin content, and also in the mechanical properties of the surface used for bonding.

Most moulded linings are suitable for bonding, and have a good surface free from excess resin and other deleterious matter. They usually show a lower shear at room temperatures, but maintain it much better than the woven ones at higher temperatures.

TEMPERATURE.—The chief agency resulting in failure of brake linings is temperature; the temperature reached may range from freezing to 100-150 degrees C. on light car and commercial vehicle applications and to as much as 350 degrees C., or over, under extreme conditions with commercial passenger and goods vehicles. It was therefore necessary to test the bonding process for resistance to such temperatures. It was first of all established that the temperature of the bonding surface was surprisingly near that of the working face (at 110 degrees C., as close as 10 degrees); tests were therefore carried out at room temperature, 150 degrees C. and 300 degrees C. with various linings. Under favourable conditions a moulded liner showed as much as 90 per cent. retention of shear strength even at 300 degrees C. while a woven material lost 90 per cent. At 100 degrees C., however, the difference is not great and many woven liners have given excellent service results.

The strength of the adhesive under these conditions is greater than that of the lining, and it is very rare to have a pure glueline failure, providing the layer of adhesive is not too thick.

SOLVENT.—It is of great importance that most of the solvent should be removed from the adhesive film before bonding, and for this reason alone there is some advantage in precoating liners. Excess of solvent will have the effect of lowering the viscosity of the adhesive at bonding temperatures, with the result that an undue ejection of resin from the glueline will take place resulting in a starved joint. Considerable bubbling and blistering may also occur in extreme cases. This may all be avoided by oven treatment under controlled conditions of the cemented liner and shoe. Treatment for 30 mins. at 60 degrees C. or one hour at 40 degrees C. is more effective than 12-15 hours at room temperature.

PRESSURE.—The effect of pressure during bonding differs greatly with different adhesives, but in practice, provided that there is sufficient pressure to bring the liner and shoe surfaces together with a glueline of 21 thousandths and that the pressure is well maintained during curing, 30-40 p.s.i. is the minimum desirable, a good bond will be obtained, though with some adhesives an appreciable loss will be suffered unless this is increased to 100 p.s.i.

BAKING-TIME TEMPERATURE.—The strength of the bond increases very rapidly in the initial stages and, as will be seen from the graph, after about an hour under the particular conditions used, the rate of increase fell off, though appreciable increase took place for at least a further hour. A difference of some 10 degrees C. doubles the curing time, and it is generally found that better bonds are obtained at the higher temperatures, and though the significance of this is not clear, it may be due to the glueline passing more quickly through the liquid stage, with rather less loss by exudation.

A riveted joint does not fail by shear but by a combination of tensile failure of the lining and the rivet pulling through the elongated hole. The rivets almost never fail. A brake lining 1¾ ins. by 9 ins. will normally have five pairs of rivets giving total strength of 4,600 lb. A similar bonded liner has a total strength of 9,600 lb.

SUCCESSFUL DESIGNING FOR PLASTICS MOULDING.

(*Continued from page 361*).

Secondly, owing to the small diameter of the wire, the resultant small surface area of the knurled portion would be bound to give very inferior " keying " to such an insert, in comparison to that obtained with other methods already described.

For these reasons, therefore, knurling will rarely be employed with wire inserts, and only then in those cases where the wire diameter is large, the material has reasonable hardness, and when the moulded-in piece will not be subjected to any appreciable turning or pulling-out pressures.

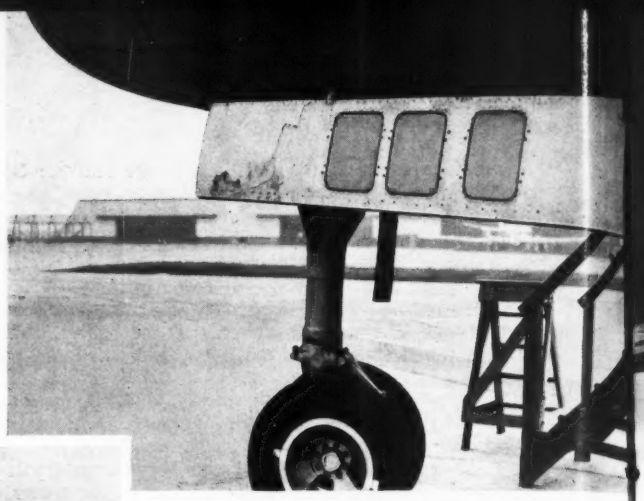
Generally speaking, when designing wire-type inserts these should be fashioned in such a manner to ensure economy of manufacture, especially in respect of the heading formation by which the parts will be keyed in place. The facility with which such formed inserts may be mounted correctly in the mould should also receive careful consideration. In all cases, ragged edges, sharp corners, and very acute bends must be avoided, as these will often lead to concentrated overstressing of the wall structure, and resultant cracking, due to internal shrinkage movements and strains. These conditions, in turn, may easily lead to some serious failure or disturbance of the insert during service use.

(*To be continued.*)

PLASTICS
IN THE SERVICE OF MAN

A pictorial review of high-quality units moulded or otherwise fabricated in Great Britain . . .

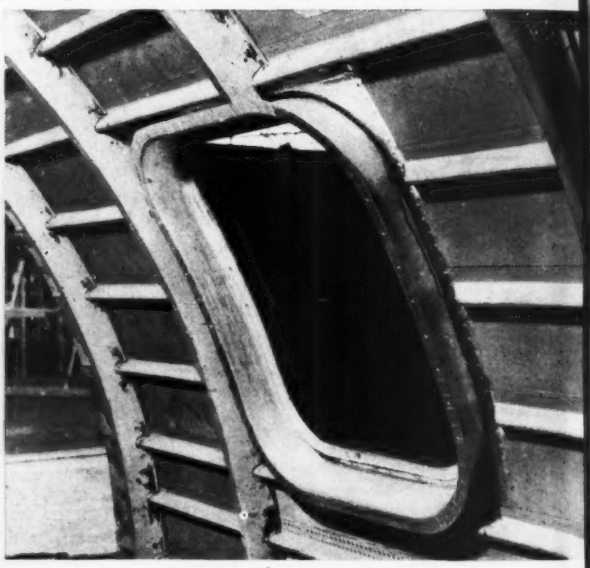
23. Aircraft

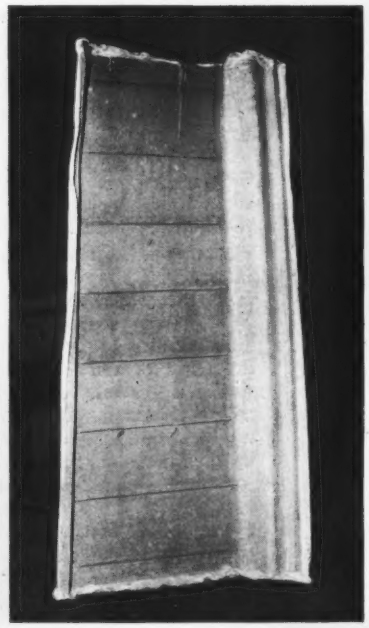


(Above) The three resin-bonded glass fibre panels in the undercarriage flap of the De Havilland "Comet" form part of the aerial system and are manufactured in the Plastics department of De Havilland Aircraft Co., Ltd.

(Below) The construction of the "Comet" makes extensive use of "Redux" synthetic resin adhesives manufactured by Aero Research, Ltd. The photograph shows horizontal fuselage stringers and a window frame bonded to the fuselage by this method.

(Above) The De Havilland "Comet" jet airliner besides employing "Redux" synthetic resin adhesives in its construction, also has many plastics components including tailplane tip aerial housings, air ducts, etc. of resin/glass fibre laminates, double-glazed windows and many interior fittings of "Perspex."

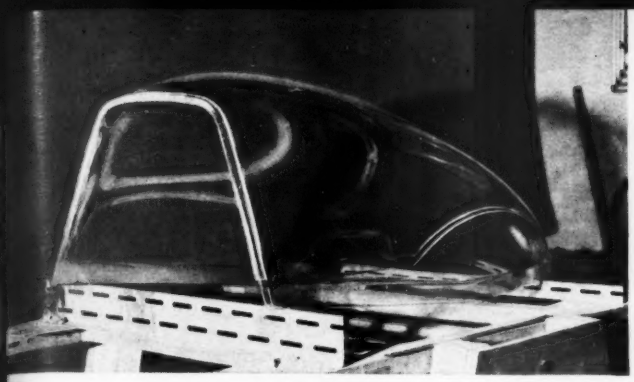


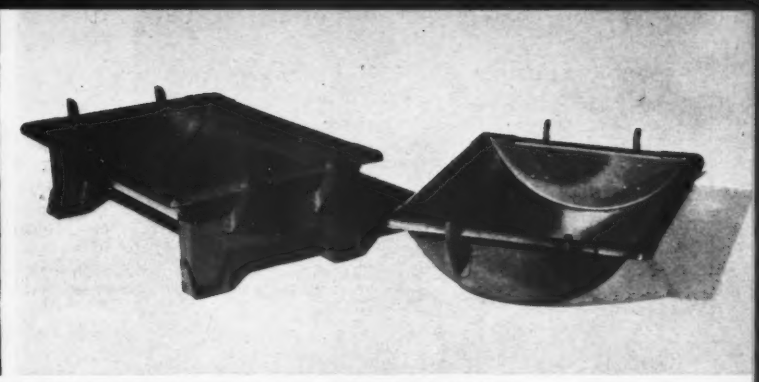


(Right) A resin-bonded fibreglass laminate made by Thermo-Plastics, Ltd. for an Airspeed aircraft is seen here before trimming.

(Below) The Westland Sikorski S-51 helicopter cabin is entirely glazed with "Perspex." Single curvature panels are grease moulded, spherical sections are free blown.

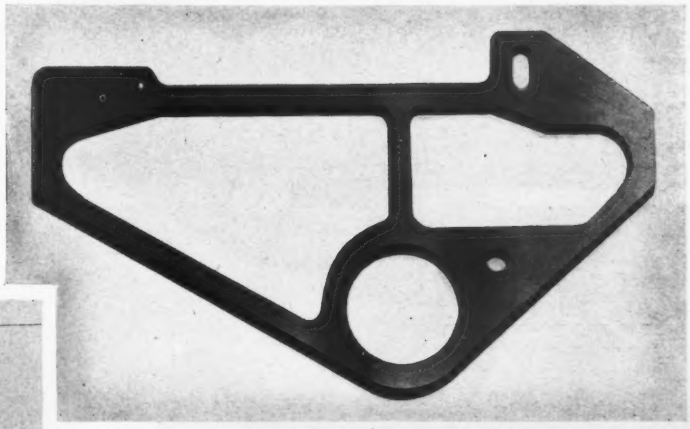
(Left) This wing, an example of work on complete aircraft structures based on plastics, was made at the Royal Aircraft Establishment, Farnborough, using "Durestos" phenolic resin-bonded asbestos felt. ("Plastics" 1951/Oct/277).



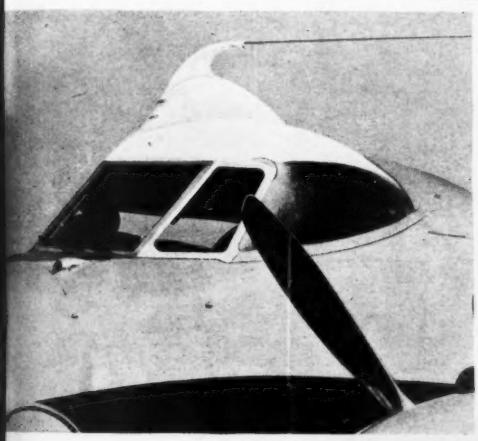


(Above) A moulded "Perspex" shell made by Thermo-Plastics, Ltd., for the hood of a Hawker aircraft.

(Right) The insulating and mechanical properties of "Tufnol" laminate sheeting are used in many aircraft components, such as this machined instrument panel. (Photo: Tufnol, Ltd.)



(Above) Parachute racks are manufactured by Thermo-Plastics, Ltd., from post-formed "Bakelite" laminates because of the low weight and greater strength of this material.

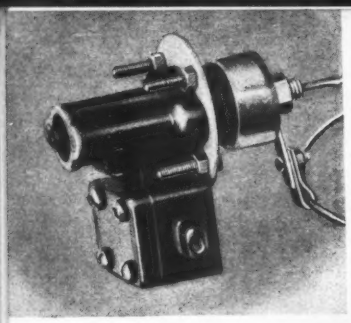


(Above and right) "Perspex" fabrications mounted over the dome of the cockpit to house the ariel system give a distinctive appearance to the de Havilland "Dove."

(Above) Because fibreglass-polyester resin laminates transmit Radar signals, these materials are used in the construction of radomes to house aircraft radar equipment. This group, manufactured by de Havilland Aircraft Co. Ltd. is being coated with "Neoprene" to resist rain erosion.

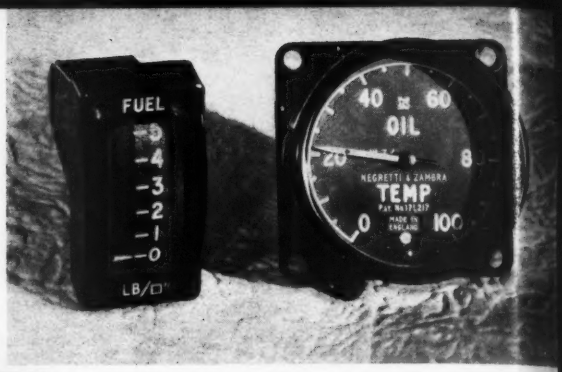
(Below) To give the necessary rigidity, radomes include a light-weight core between fibreglass laminate "skins." The two experimental radomes by Thermo-Plastics Ltd. use expanded rubber and fibreglass honeycomb.

(Left) This pilot's seat made for Fairey Aviation Co. Ltd., by their subsidiary, Aeroplastics, Ltd., from phenolic mouldings has been approved for 25 G crash landings with a load of 256 lb.

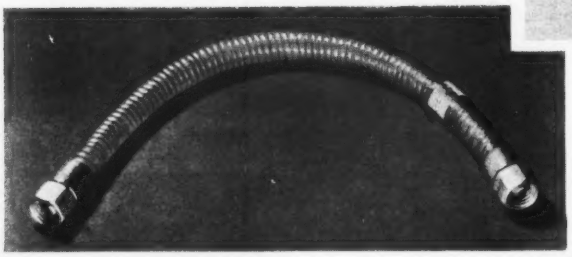


(Left) The range of aircraft fire-protection equipment made by Graviner Manufacturing Co., Ltd., uses many plastics mouldings, such as the housing for this pyrotechnic flame switch.

(Below) Petrol- and oil-resistant polyvinyl chloride extrusions are used in aircraft fuel systems.

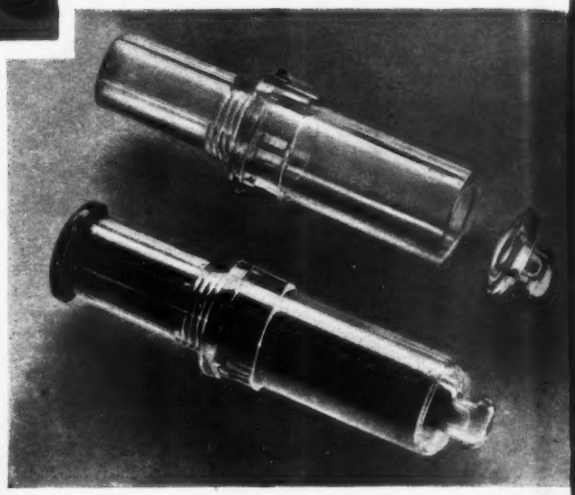


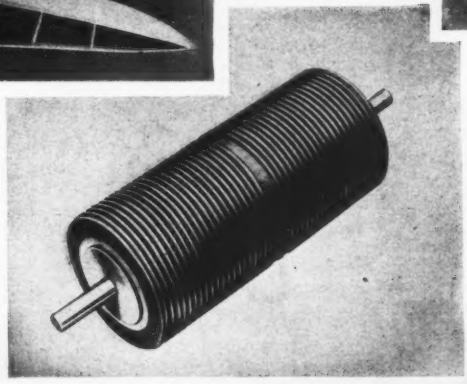
(Above) Housings of aircraft instruments are manufactured from "Bakelite" phenolic moulding materials. (Photo: Bakelite, Ltd.)



(Below) Some of the resin-bonded fibreglass laminate structures made by de Havilland Aircraft Co., Ltd., for the "Comet" airliner. The parts include tailplane aerial housings and air ducts.

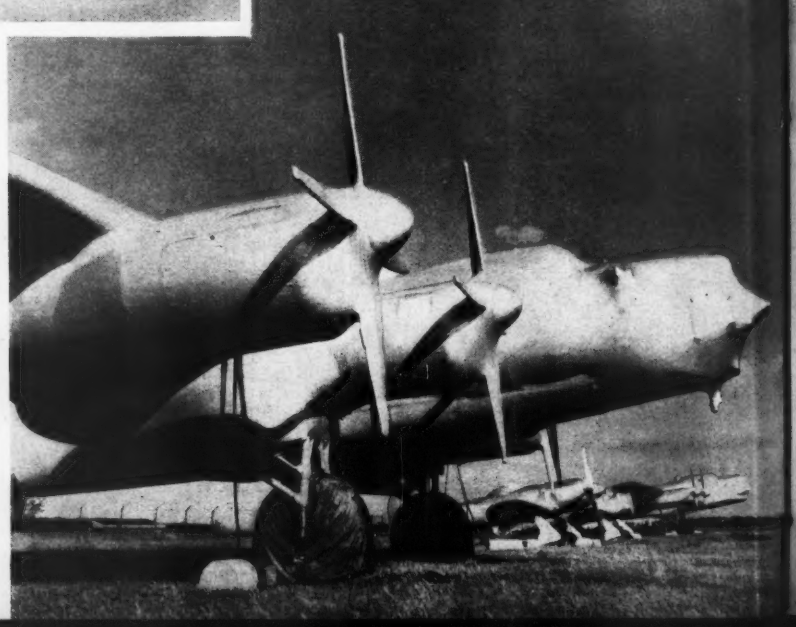
(Below) Multiple pulley for carrying aircraft control wires, machined from "Tufnol" laminates.





(Above) Hygroscopic silica gel is sealed into this moulded "Diakon" container. When the seal is broken the tube screws into the sparking plug thread of aircraft engine cylinders and prevents corrosion during storage. Excess moisture is indicated by colour change in the silica gel. The mouldings are made by Thermo-Plastics, Ltd., for B.O.A.C. and other airlines.

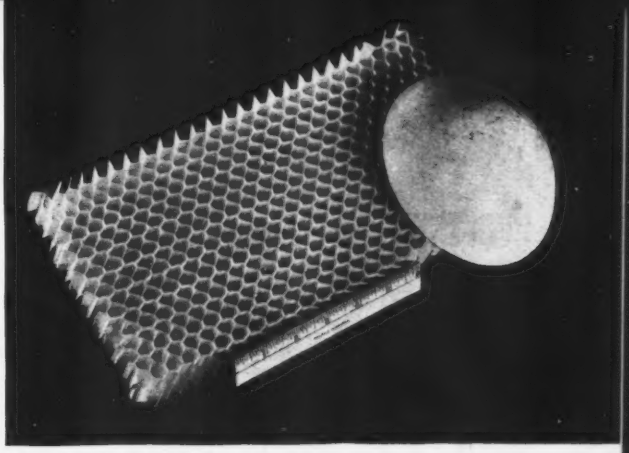
(Below) Coloured transparent "Glimdomes" injection-moulded in "Diakon" acrylic material, are made by British Moulded Plastics, Ltd., for Ministry of Supply for use in portable runway marking lights.



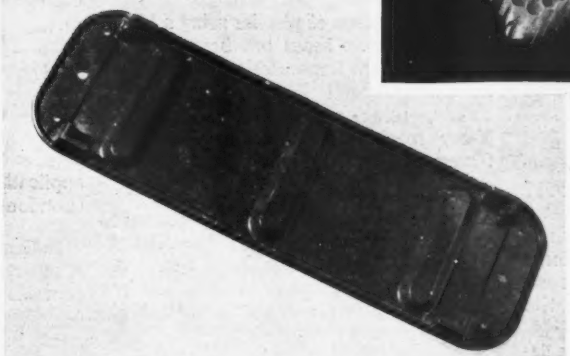
(Right) Anti-corrosion protection is given to these R.A.F. Lincoln bombers by the "Cocoon" process of R. A. Brand and Co., Ltd., in which a plastic skin is sprayed on by means of a webbing agent incorporated in a vinyl resin solution.

(Above) This prototype fabricated by J. Starkie Gardner, Ltd., is typical of the use of "Perspex" in navigational instruments.

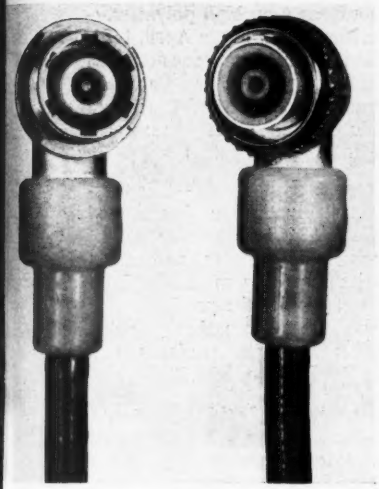
(Below) Acid-resisting accumulator drip trays moulded in phenolic material are manufactured for Fairey Aviation Co. Ltd. by Aeroplastics, Ltd.



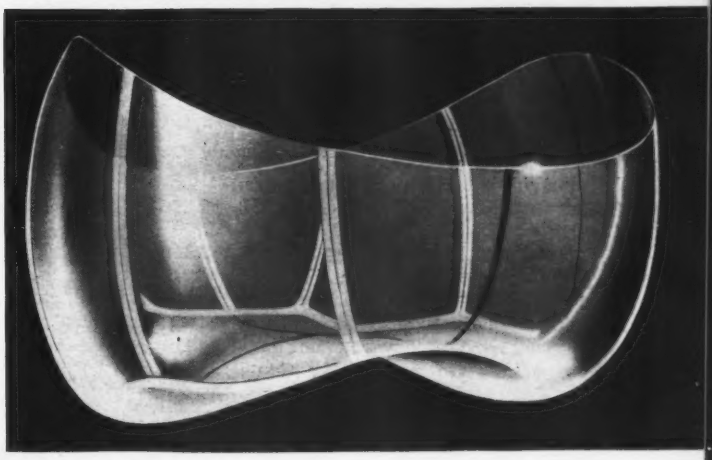
(Above) Honeycomb structure made by Thermo-Plastics Ltd. from glass cloth polyester resin laminates is used as lightweight core material in radomes and other aircraft components.



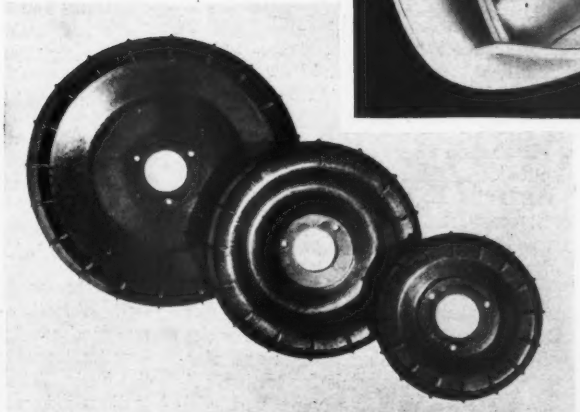
(Below) One of the most complicated fabrications in "Perspex" is the "Camel" radome made by Thermo-Plastics Ltd. for the Avro Lincoln bomber. The shaped sections are joined together by welding.



(Left) This concentric extra high tension plug and socket moulded in polythene by the Plessey Co., Ltd., enables 10,000 volts to be adequately handled under pressure-tight water-tight conditions at high altitudes.

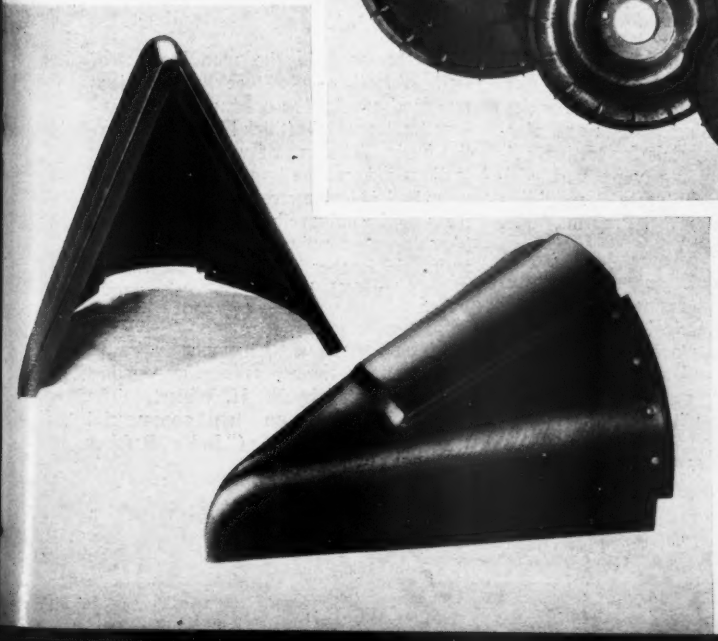


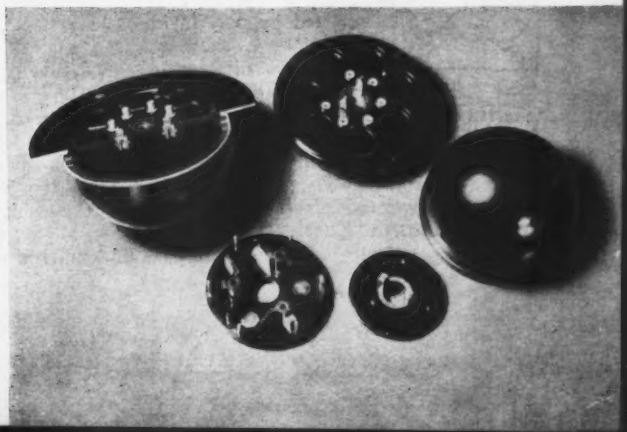
(Below) Fairings shaped from black cellulose acetate are made by Thermo-Plastics, Ltd., for Blackburn and General Aircraft, Ltd.



(Left) Handwheels for aircraft controls such as aileron, elevator and rudder trim controls are moulded in phenolics by Aeroplastics, Ltd. for Fairey Aviation Co. Ltd.

(Below) "Bakelite" phenolic mouldings are used in the construction and housing of the flux valve in the Gyrosin aircraft compass made by Sperry Gyroscope Co., Ltd. (Photo: Bakelite, Ltd.)





World's Industry Employs Plastics

GENERAL ENGINEERING

Nylon bearing liner.—A new bearing, made by Thomson Industries, Inc., Manhasset, New York, consists of an outer sleeve of metal and a thin lining of nylon bearing material. The liner is retained in the sleeve which permits expansion and contraction and has a narrow compensation slot. ("Automotive Industries," 1951/Sept. 15/64.)

Neoprene radiator hose.—A bus and truck radiator hose consists of an inner tube of 3/32-in. average thickness compounded from Neoprene. ("Automotive Industries," 1951/Sept. 15/110.)

Forming methods for polythene are described by K. Rose. They consist of a modified casting process, a new joining method and means of applying coatings. ("Materials and Methods," 1951/Oct./88.)

Moulded gears.—In a survey on methods of forming gears, design considerations are given on plastics gears. Several plastics, in particular nylon, can be moulded to close tolerances. ("American Machinist," 1951/Aug. 20/114.)

Production and assembly costs reduced by reinforced plastics.—The Fairchild Camera and Instrument Co. has replaced the aluminium housing of their photoelectric engraving machines by reinforced plastics. They are made by Le Conte Plastics Co., of "Laminac" resin and two layers of fibreglass. ("Tooling and Production" (formerly "Tool and Die Journal"), 1951/Oct./166.)

Production of sieve holes in plastics.—H. Turnwald gives hints how square sieve holes can be moulded in plastics, and how the burr can be easily removed. ("Kunststoffe," 1951/Oct./360.)

ELECTRICAL

Resistance of polyvinyl chloride insulation against water and d.c. current.—Electric cables insulated by polyvinyl chloride showed damage, discoloration and destruction different from those of dielectric failure. These faults only occur on the negative pole of direct current systems when exposed to high humidity or water. The deterioration was thoroughly investigated by O. Leuchs. ("Kunststoffe," 1951/Oct./309.)

High-frequency welding.—K. Pfeifer gives a short survey on the principle of high frequency welding of plastics foils of polyvinyl chloride and some welding apparatus developed by Allgemeine Elektrizitats Gesellschaft. ("Werkstatt and Betrieb" (Austria), 1951/Oct./285.)

Polymerization of plastics using a high-voltage electron beam has been effected at the Research Laboratories of the International General Electric Co. Schenectady, using a modified million-volt X-ray machine. ("Machinery Lloyd" (Overseas Edn.), 1951/Sep. 29/111.)

Dielectric behaviour of plastics.—F. H. Müllers shows that the dielectric constant and the loss angle can be interrelated with structure and other properties. A quantitative evaluation is possible by using the dipole theory. ("Kunststoffe," 1951/Sept./277.)

MISCELLANEOUS

Properties of plastics floor coverings.—H. Casper describes apparatus for the mechanical testing, in particular wear testing, of plastics floor coverings. The durability is further influenced by hardness, compressibility, elasticity, water absorption, tensile strength, elongation, etc. ("VDI-Zeits," 1951/Oct./926.)

Plastics in Brazil.—The development of the plastics industry in Brazil is shortly described, restrictions and raw material difficulties discussed. ("Chemical Age," 1951/Sept./432.)

Report on Plastics.—In a report on the activities of the ASTM Committee D-20 on plastics, the following new tentative test standards are announced: bursting strength of round, rigid plastics tubing; measuring warpage in sheet plastics; apparent density and bulk factor of granular thermoplastic moulding powder. Revisions were proposed for: definition of terms, conditioning plastics and electrical insulating materials for testing, cellulose acetate moulding compounds, cellulose acetate butyrate moulding compounds. ("A.S.T.M. Preprint," No. 81, June 18-22, 1951.)

New vinyl formulations.—K. Rose reports on new vinyl resins developed by B. F. Goodrich Chemical Co.: (1) a polyvinyl chloride to be compounded in the standard way with plasticizers, pigments, fillers, etc., being easily processed; (2) polyvinyl chloride with excellent clarity, heat stability and good strength for rigid or semi-rigid uses; (3) vinylidene chloride copolymer directly soluble in organic solvents to be used for solution coatings. ("Materials and Methods," 1951/Sept./148.)

Whipped-cream dispenser.—A new Araldite coating resin prevents the destructive action of fatty acids on aluminium as worked out for Kidde Manufacturing Co. ("Materials and Methods," 1951/Oct./111.)

Applications of plastics.—H. V. Potter gives a general survey of the present state of development of new plastics and their applications in industry. ("Nature" (London), 1951/Aug. 25/328.)

Indian conference on high polymers.—A report on this conference in April, 1951, contains data on estimated consumption of plastics, available raw materials, natural and synthetic plastics. ("Journal of Scientific and Industrial Research" (New Delhi), 1951/Sept./355.)

Testing moulding materials.—The German Standards Institution has issued recently: DIN 53468 Determination of heaped weight of powder and short stable plastics moulding materials; DIN 53470 Press tools for the production of standard test pieces from thermosetting resins. (Copies from Brit. Standards Inst., 28, Victoria St., London, S.W.1.)

Bending analysis of thin plastics.—H. H. Hebeler and Coll. have developed a new electronic flexometer which facilitates bending analysis and stiffness studies of fabrics and thin plastics. The measuring element undergoes little motion during the bending cycle, which has a variable but controlled bending rate. ("ASTM Bulletin," 1951/pp/52.)

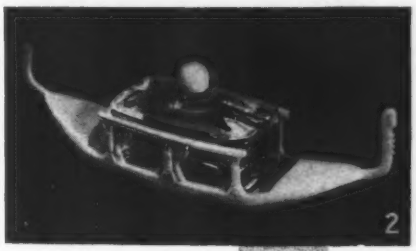
Maintenance and cleaning of "Plexiglas."—F. Esser compiles useful recommendations, which are not widely known. He warns in particular against using the usual household cleaners. ("Kunststoffe," 1951/Oct./361.)

Development in the manufacture of artificial leather.—K. Stoeckhert describes two methods for the production and surface treatment of artificial leather on textile basis. The use of various polymers is discussed and the important position of polyvinyl chloride stressed; new applications of the polyurethenes are mentioned. (A sample of polyvinyl chloride coated artificial leather by Wachstuchfabrik Griesheim K.G. is attached to the copy.) ("Kunststoffe," 1951/Oct./329.)

Classification of thermoplastic resins according to their plasticity curves has been attempted by W. H. Willert. The results of tests on ten commercial products are given. ("India Rubber World," 1951/Mar./324.)

COSMETICS CONTAINERS AND PACKS

A Selection of Plastics Mouldings for Novelty Christmas Gifts



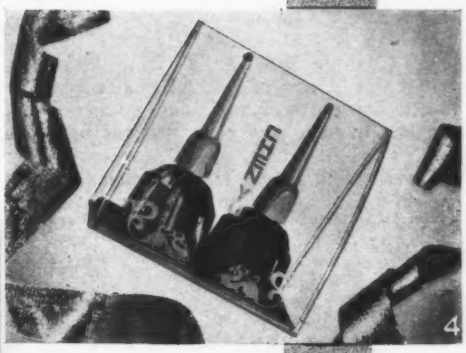
1 and 2. Polystyrene packs for Potter and Moore's lavender, moulded by International Bottle Co.

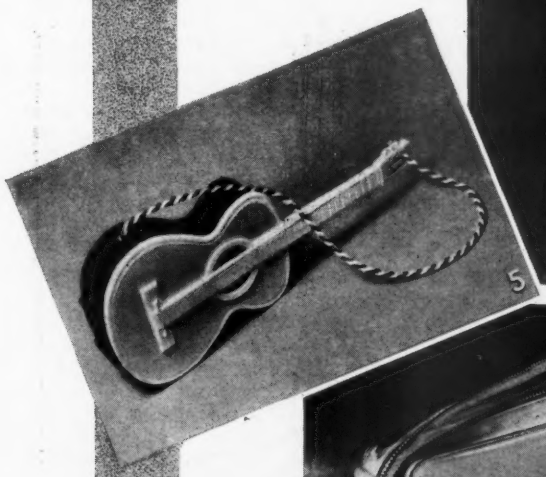
3. Champagne bucket by Godfrey Holmes (Plastics), Ltd., and "Marble Arch" moulded by Prestware, Ltd., form the latest packs for Bourjois "Evening in Paris" perfume.

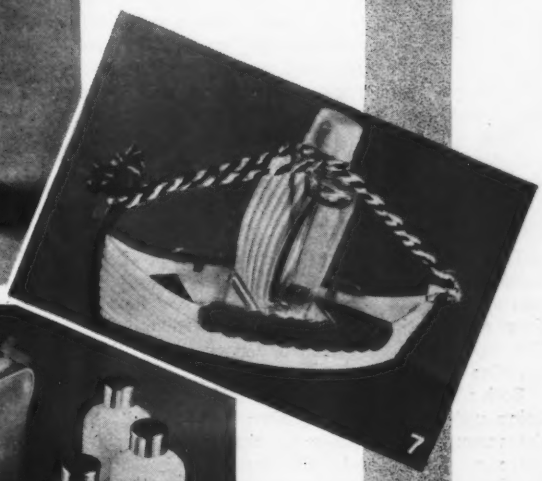
4. "Chen-Yu" nail varnish is presented in transparent cellulose acetate containers.

5, 6 and 7. A compression moulded guitar and polystyrene ship and lighthouse mouldings are used by Delavelle for their "Blue Orchid" perfume packs.

8. "Poly-Tainer" plastics travelling sets for cosmetics are seen on many Christmas gift counters. The latest set, introduced by Industrial Appliances, Ltd., includes fluted jars and bottles with textured surface.







Cementing Thermoplastic Mouldings—III

By VIVIAN STANNETT, Ph.D., M.Sc., F.R.I.C., and D. W. JAY

This concluding instalment treats of the toxicity characteristics of solvents employed in cementing thermoplastics. From the toxicity point of view these solvents may conveniently be divided into three groups : I—Low toxicity. II—Risk attached to use. III—Definite toxicity.

THE solvents used in the adhesives discussed in the second instalment of this article will now be considered from the viewpoint of hazard in use.

ACETONE.—This solvent is given Group I status, indicating that it is of low toxicity. Breathing strong vapours causes irritation to mucous membranes and can cause loss of consciousness, but removal to fresh air and possibly artificial respiration in very badly affected cases give complete recovery. There are no prolonged effects and no toxic symptoms have been observed in workers using the solvent over many years. It has even been said that epidemics of influenza and bad colds are less severe in the case of these workers.

Acetone is the most widely used of cellulose acetate solvents. From Table 1 ("Plastics," November, 1951, page 311) it will be noticed that the boiling point is low and the vapour pressure high, indicating a very volatile substance—and one wherein used concentrations of vapour can easily be built up if no care is taken. The solvent is very inflammable and burns with a very faintly luminous flame. There is a danger that an open dish could become ignited and not be noticed until it has set fire to other materials.

Explosions of vapour-air mixture are far more dangerous and the lower limit of 2.13 per cent. by volume in air could soon be built up. The upper limit is 13 per cent., above which the mixture does not explode, but this figure is of no value for a room where there are currents of air and in any case would be unbreathable.

METHYL ACETATE AND ETHYL ACETATE.—These are very widely used solvents and both can be included in Group I for toxicity. No serious long-term toxic effects have been reported. In concentration the vapours cause irritation to the mucous membrane and the methyl compound does cause headaches.

Both compounds are inflammable and form explosive mixtures in air, methyl acetate needing 4.1 per cent. lower limit and ethyl acetate 2.2 per cent. by volume of gas. They are very volatile, and hence explosion dangers must be guarded against by adequate ventilation.

METHYLATED SPIRIT (Group I).—Several forms of this solvent are available, but for practical purposes they all contain 95 per cent. ethyl alcohol denatured by the addition of 5 per cent. methyl alcohol. This is known as industrial spirit. The spirit may be further denatured by the addition of pyridine and voilet dye or with diethyl phthalate.

Both alcohols have toxic effects, that of the ethyl compound being well known. It is often not realized that breathing the vapour can produce all the symptoms of intoxication more readily than imbibitions. Ethyl alcohol is readily oxidized in the body to carbon dioxide and water and toxic effects are not great; damage to the liver, sometimes mentioned, does not seem to have been proved.

The methyl alcohol content, however, is far more toxic. It accumulates in the system and is only very slowly oxidized to formic acid and formaldehyde. The symptoms of toxicity range from digestive disturbance to blindness and insanity. Absorption through the skin over long periods can give rise to toxic symptoms. But methylated spirit cannot be regarded as a dangerous solvent when used for its proper purpose in the ordinary way. It is well to note that it forms explosive mixtures with air, and due care as to ventilation should be taken.

CELLOSOLVES.—These are, chemically, glycol compounds. Glycol itself can be considered as an intermediate between a simple alcohol and glycerine. Methyl cellosolve is one of the commonly used solvents for cellulose acetate and cellulose nitrate. Together with methyl cellosolve acetate it is included here in Group I. Both compounds have a low volatility and no difficulty is likely to be experienced from vapour inhaled and no toxic effects have been reported. It is as well to know that under certain conditions decomposition can take place with the formation of methyl alcohol. Explosive mixtures with air are formed with proportions as low as 1.7 per cent. for the acetate compound and 2.6 per cent. for cellosolve at elevated temperatures. They are, however, safe to use at room temperature.

ETHYL LACTATE, DIACETONE ALCOHOL AND ACETONYL ACETONE.—Although belonging to different chemical groups, these are linked here in Group I as being for practical purposes, non-toxic substances. They have low vapour pressures and hence low rate of evaporation, so that no difficulty would ordinarily be experienced from vapours evolved. No toxicity has been noted and the fire risk is low.

METHYL ETHYL KETONE.—This solvent, in Group I, is very similar to acetone in its effects on the body, but may be considered somewhat more irritating if breathed in concentration. It does not appear to produce any lasting symptoms. The fire and explosive risks are noteworthy: it is only slightly less volatile than acetone and forms similar explosive concentrations in air, from 2 per cent. to 12 per cent. by volume. In use one should take all the precautions necessary in the case of acetone.

The solvents in Group II possess some rather different properties to consider, and for convenience this group is sub-divided according to physical properties.

The members of sub-division A (which are also more toxic than those of sub-division B) include carbon tetrachloride, trichlorethylene, perchlorethylene, methylene chloride and ethylene dichloride. A glance at the physical properties in Table 3 ("Plastics," October, 1951, page 282) shows that all these solvents possess a high density and it follows that the vapours are correspondingly heavier than air. While it has been previously stated that all the solvents used here

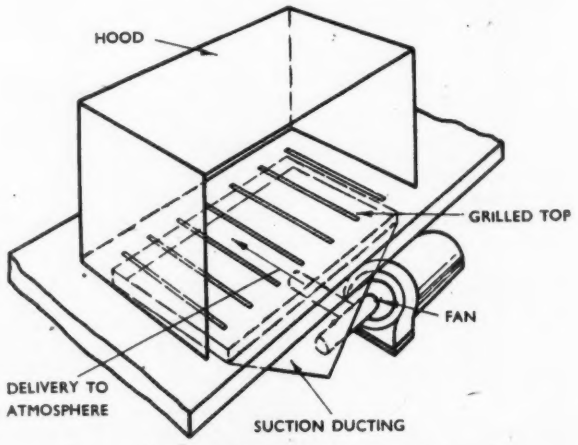


Fig. 1.—Working cabinet, with extraction of vapour at low level.

have vapours heavier than air, most can be drawn away from a work-cabinet from the top.

The vapours of the solvents in this instance would be more safely drawn away at a lower level, see Fig. 1, as they sink rapidly even in fairly strong air currents. Cases have been known where roof ventilation fans have drawn these heavy vapours up and away from a work space, only to be insufficient to remove them completely. Sinking down, collections of vapour have formed many yards away, often in a different department, adversely affecting workers who would normally be judged to be well away from any risk.

As to specific toxic effects, all these substances are narcotics, i.e., they produce an artificial condition of sleep with very ill effects afterwards.

CARBON TETRACHLORIDE has perhaps the most toxic action on prolonged usage. Exposure to concentrations of the order of 100 parts per million causes injury to the liver and kidneys. The prominent symptoms are loss of weight and appetite, mental confusion and sight disturbance. Sometimes the toxic effects appear some days after exposure to concentrated vapour.

TRICHLORETHYLENE.—This substance has a similar narcotic effect and deaths have been reported from only short exposures to moderately high concentrations of vapour. No cumulative toxic effects on the body have been reported, but owing to its high volatility, dangerous narcotic concentrations can rapidly be built up if ventilation factors are not considered.

METHYLENE CHLORIDE.—This solvent is not so narcotic in its action as carbon tetrachloride, but its rate of evaporation is so very high that dangerous concentrations can very rapidly be reached. Headache, difficult breathing and leg and arm pains are indications of its poisoning action, but no lasting ill-effects have been noted.

PERCHLORETHYLENE.—From the narcotic effects produced by this group of solvents, Perchlorethylene has the smallest immediate toxic action, but its mildness in this respect is offset by damage it can cause to the liver and kidneys on prolonged usage. Concentrations of 30,000 parts per million of air have had fatal results when inhaled for only a short time.

ETHYLENE DICHLORIDE.—The powerful narcotic action and certain toxic action affecting the nerves of the stomach have not made this a widely used solvent, especially as in a large number of applications it has no advantages over trichlorethylene. It is, nevertheless, a good solvent for polystyrene. With the exception of ethylene dichloride, all the solvents included in this subdivision are non-inflammable, which makes the specification of electrical equipment for adequate ventilation less rigorous in that flame-proofing is not required.

A point of considerable importance is that decomposition of the vapours of these chlorinated compounds takes place in a naked flame. The very poisonous and irritating gas, phosgene, is produced, the potentialities of which, as a war gas, should be sufficiently known. A rough test for the presence of vapour is the green tinge produced in, say, a Bunsen burner flame when this decomposition is taking place.

ETHYL BENZENE, DIETHYL BENZENE AND AMYL BENZENE; ALSO ETHYL AND DIETHYL NAPHTHALENE.—These solvents comprise sub-division B of Group II. From the physical properties, Table 2 ("Plastics," October, 1951, page 282), it will be seen that they are all of a low order of volatility; toxic symptoms are slight and no delayed ill-effect has been noted. They have not been widely used in this country and most development has taken place in America, where they have been shown to be valuable for use with polystyrene. The three benzene derivates are all inflammable, and this risk must be guarded against, but the naphthalene compounds do not readily burn.

BENZENE, XYLENE AND TOLUENE.—These are coal tar products, and fall under Group III. Benzene or benzol should be distinguished from the mixed product known as "benzine," obtained from petroleum distillation. While benzine does not find wide use as a plastics solvent, benzene is in comparatively common use and its toxicity is very high.

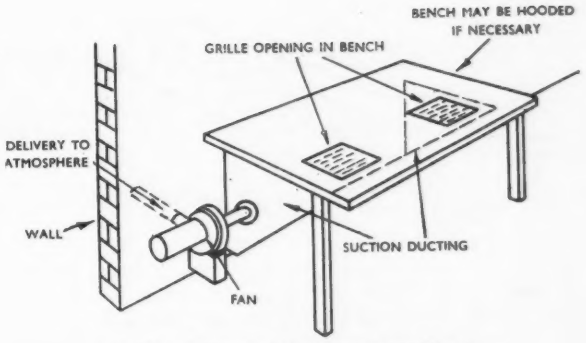


Fig. 2.—Extraction of vapour at bench level.

Benzene has a paralyzing action on the nervous system and concentrations to the order of 3,000 parts per million have been known to render the operator unable to move away from the workbench to safer surroundings. While the immediate action of benzene is on the central nervous system, prolonged usage leads to severe anæmia due to damage to blood-forming cells. A concentration of 100 parts per million is said to be the maximum permissible for safe contact, but it is far more satisfactory to ventilate sufficiently to remove any possible risks.

The effects of toluene are similar to benzene, and it produces a similar effect on the nerves. However, it does not have the same prolonged effect of causing chronic illness. It is widely used industrially and it is generally agreed that it is far less dangerous than benzene in actual use. High concentrations, however, must be regarded as dangerous.

Xylene is possibly the least toxic of these three solvents, but high concentrations will produce giddiness and loss of consciousness. It must be used with care as prolonged contact does cause damage to the kidneys and blood circulation.

MIXED SOLVENTS.—From the standpoint of toxicity, as well as fire and explosive hazards, just as much care must be taken with mixtures as with single solvents. For example, an azeotropic mixture with an increased vapour pressure may have a lower flash point and greater explosive risk in its air/vapour mixtures than any single component. However, it is not possible here to give a list of such mixtures, but tables will be found in most text books dealing with the subject.

The value of mixtures has been indicated in the foregoing article dealing with the formulation of cements. A very volatile, but valuable, solvent such as methylene chloride may be much more easily used if the rate of evaporation is reduced by mixture with perchlorethylene. Again, azeotropic mixtures such as benzene and ethyl alcohol may exhibit greater solvent powers than either of the single solvents.

Ventilation of Workrooms

Power for air extraction is undoubtedly the most practical method of preventing build-up of vapours. For general use with cellulose cement solutions, the recommended rate of air change is 30 times an hour. (Arthur Jones, "Cellulose Lacquers, Finishers and Cements.") In a room of 10 ft. by 30 ft. by 20 ft. (6,000 cubic ft.) this would necessitate removal of 180,000 cubic ft./hour, or 3,000 cubic ft./minute. A centrifuge-type fan powered by a motor of approximately 17 h.p. would be needed for this quantity.

For small work a cabinet is the best proposition, open on the work side. A size 10 ft. by 3 ft. by 3 ft. requires 2,700 cubic ft. air per hour, or 45 cubic ft./minute, to be extracted. Only a small fan would be needed for this.

It is well to avoid ducting, where possible, to ensure a clear

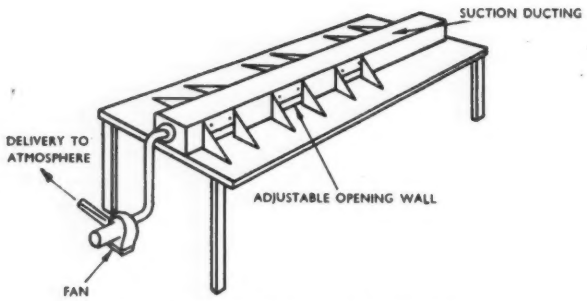


Fig. 3.—Extraction of vapour at bench level.

air current. If the cabinet is placed near a wall, it is usually convenient to take a straight pipe through. Baffles should be arranged outside to prevent winds causing a blow-back.

Usually it is more convenient to extract air from the top of cabinets and for a large number of solvents this is quite suitable, but where the vapours are heavy as, for example, those mentioned in Group 2A, extraction is best effected at bench level (Figs. 2 and 3).

Valuable information on ventilation is contained in a publication by H.M. Stationery Office, Welfare Pamphlet No. 5, "Ventilation of Factories and Workshops," now being reprinted.

Safety Regulations

At this point it may be useful to mention the chief regulations governing the use of the materials dealt with here.

The general Factories Act, 1937, applies, of course, to all work places and should be consulted. The Sections of greatest interest are:—

34-37:—Fire precautions and fire escapes.

47:—". . . in particular where the nature of the process makes it practicable, exhaust appliances shall be provided and maintained as near as possible to the point of origin of the dust or fume or other impurity, so as to prevent it entering the air of the workroom."

66:—"Notifications of Industrial Diseases."
S.R. and O., 1915, No. 1170 deals with the notification of cases of toxic jaundice caused by tetrachlorethane, nitro and amino derivatives of benzene or other poisonous substances.
S.R. and O., 1924, No. 1505 covers chronic benzene poisoning.
S.R. and O., 1942, No. 196 covers toxic anæmias.

While these are the main points of importance in the general Act, a specific reference to solvents, etc., is made in the Section on Regulations for Dangerous Trades. These are called "Cellulose Solution Regulations," S.R. and O., 1934, No. 990, and apply to solutions of cellulose compounds which have a flash point of less than 90 degrees F. The requirements are exacting and describe the fire-resisting constructional materials for rooms and cabinets, storage and use. Clause 5b concerning electrical fittings is noteworthy where lamps and resistances liable to heat up to 180 degrees F. or more must be so protected as to prevent any of the material being used becoming deposited.

Where only small quantities of cellulose solutions are used, certain relaxations are allowed. These are contained in the "Certificate of Exemption" (Cellulose Solutions Regulations, 1934) Form No. 1985 (May, 1938).

The relaxations apply to the use of special cabinets specified in the main regulations and the ventilation thereof and also to fire escapes. The relaxations apply only if:—

1. The total quantities of cellulose solutions and other inflammable liquids, together, consumed in the "cellulose space" do not exceed 4 pints on any day.
2. The total quantities of cellulose solutions and other inflammable liquids, together, present in the "cellulose space" do not exceed 2 pints at any time.
3. The cellulose solutions in use in the "cellulose space" are kept in containers so designed as to prevent spilling of the liquid and holding not more than four ounces each. (Examples may be seen at the Home Office Industrial Museum, Horseferry Road, S.W.1.)
4. The cellulose solutions and other inflammable liquids do not contain (a) benzene (benzol), (b) toluene, (c) xylene, (d) any halogenated hydrocarbon (Group 2A, for example.)

The regulations go on to state that the cellulose solutions or inflammable liquids must be procured or stored in receptacles clearly marked as being free from the above solvents, or that a certificate is obtained from the makers of any solutions that they do not contain these solvents.

Advice and guidance on all aspects of these regulations can be obtained from the Inspector of Factories, Engineering and Chemical Branch, Artillery House, Artillery Row, S.W.1.

Protection for the Hands

Many of the solvents used in plastics are also grease and fat solvents and tend to remove the natural oils from the skin. If the hands and arms are in frequent contact with such solvents, dry, scaly conditions develop. Cracks form and are very liable to infection as the natural grease of the skin possesses antiseptic properties.

Gloves can be used as a protective measure, but rubber is attacked by solvents. In recent years industrial barrier cream has been developed and there are several kinds available which offer protection against these substances. Those containing one of the water soluble cellulose compounds form an invisible "glove" on the skin which is easily removed by soap and water. This factor, together with ease of application, encourages workers in their regular use, as many people are careless of their hands until serious skin troubles appear. In any case, where workers are repeatedly in contact with solvents, occasional application of lanoline or a mixture of lanoline and soft petroleum jelly, about equal parts, is a good prophylactic measure.

The writers would like to express their thanks to Mr. D. R. Crabtree, of Erinoid, Ltd., for his help in the compilation of this article.

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Plastics in Brazil

The "Observador Economico e Financeiro" in a recent article quoted local production of raw materials for the plastics industry in Brazil at 5,900 tons annually. Phenolic moulding powder is now made in S. Paulo, but phenol for the manufacture of the synthetic resin continues to be imported. Urea-formaldehyde is also manufactured locally, with imported urea. About 600 tons of cellulose acetate is made annually, using local raw materials. The first polystyrene plant in Latin America was inaugurated at S. Paulo, by Bakol S.A., in 1949. It began by producing 2,000 tons annually towards the end of 1950, but doubled its capacity in 1951, and is now preparing for a further 50 per cent. increase. Local consumption of polystyrene is estimated to be 3,000 tons annually; the surplus production is exported. The styrene monomer is imported and polymerized locally. Local consumption of vinyl plastics has reached 2,000 tons annually. Vinyl resins and sheet are imported chiefly from Great Britain; stabilizers and other materials come from the United States. In spite of expanding local production, imports into Brazil of cellulose acetate, and synthetic and natural resins, increased from 17,300 tons in 1949 to 32,170 tons in 1950.

Utilization of Ultrasonics in the Plastics Industry—II

The concluding part of this article treats of the degradation of polymers and the measurement of constants. The references given cover the whole article.

By W. S. PENN, B.Sc.

SEVERAL investigators have studied the degradation of polymers by the use of ultrasonic waves. Some natural polymers were examined[14 15], and the viscosity fall was attributed to the breakdown of the polymer molecule. Other investigators[16], however, suggested that the action of ultrasonic waves on aqueous solutions of gelatine and toluene solutions of rubber was due to thixotropic effects.

A recent article[2] by Melville and Murray has done a great deal towards clearing up the problem. It now seems quite definitely, as a result of work on synthetic polymers, that there is a genuine rupture of polymer chains. Only in the case of a solution of polyethyl acrylate was there any thixotropic effect, but even here there were also other causes of the viscosity fall.

Melville and Murray have given some interesting details of their work, particularly the experimental technique which was employed. They used ultrasonic waves with a frequency of 213 kc. per second with a total sound output of about 23 watts. Several references for the measurement of the intensity of ultrasonic waves were given [17 18]. A quartz crystal driven by the output of a valve oscillator was employed and oil was employed to prevent the shattering of the crystal. It was mentioned that initially a brass electrode was used in contact with the crystal, but this resulted in loss of half the output of power which was absorbed by the brass.

By replacing this brass electrode with a bad conductor of sound, the intensity of radiation can be gradually increased and the use of an air electrode was suggested. Greutzmacher[19] described this technique. An interesting method of tuning the crystal in order to obtain maximum sound energy was also described. This is done by obtaining the maximum height for the fountain of oil which is thrown up from the surface above the crystal face.

Details of methods of tuning have been given[20]. By the use of the apparatus described, Melville and Murray obtained some interesting results. Several polymers were examined and as an example, after a 350 minute treatment, polymethyl methacrylate and polymethyl methacrylate-acrylonitrile copolymer, with initial molecular weights of 725,000 and 615,000 respectively, gave final molecular weights of 544,000 and 385,000 respectively. The results of the ultrasonic degradation of an 0.1 per cent. solution of polystyrene in toluene are recorded below:—

Irradiation Time in minutes	Intrinsic Viscosity
0	2.70
5	2.33
10	2.19
15	2.12
20	1.96
30	1.75
40	1.63
50	1.41
60	1.38
80	1.29
100	1.12

As a result of their work, Melville and Murray have established several important principles. One of the most important of these is in connection with cavitation. It is fairly definitely established that cavitation will occur in solutions subject to ultrasonic vibrations.

It has now been definitely shown that degradation can be effected by ultrasonic waves without cavitation, if the molecular weight of the initial polymer is high enough. On the other hand the process is more efficient if cavitation occurs, which it will do if the work is not carried out under pressure. It may be mentioned in this connection that in addition to the use of pressure to overcome cavitation, there is also a pressure effect. There is a limiting value of molecular weight by this degradation method, and this is much lower in the case where cavitation occurs.

It has been shown that the degradation is much more efficient in the presence of a gas than in a vacuum. It does not seem to matter a great deal which gas is employed and oxygen, air and nitrogen have been tried. The nature of the polymer does not seriously affect the result and it seems that most polymers can be degraded. This work has also shown that the breakdown is not necessarily due to oxidative fission.

Finally, Melville and Murray have carried out some work to endeavour to elucidate the nature of the degradation products. It was considered that the rupture of carbon-carbon bonds would result in the formation of free radicals. Since the latter catalyze polymerization, it was decided to investigate the phenomenon by degrading polymethyl methacrylate in its monomer, or another monomer could be employed. As an example of this, a 1 per cent. solution of the polymer of molecular weight 725,000 was made up in freshly distilled monomer and irradiated for two hours in a vacuum. The results of this polymerization of methyl methacrylate in the presence of a degrading polymer are measured in terms of refractive index which varies linearly with percentage polymer in dilute polymer/monomer solutions:—

	Refractive index n_D^{25}	Concentration of Polymer
Monomer	1.41219	—
Approx. 1% solution	1.41288	0.885%
After 2 hours irradiation	1.41448	2.94%

It did appear from these experiments that some catalyzation was taking place and by an examination of blanks and the elimination of thermal effects this conclusion still stood. In the case of vinyl acetate, however, and with similar experiments it was difficult to detect any polymerization, and by similar experiments with styrene the implication was obtained that degradation did not result in radical production.

Measurement of Constants

The discovery of the Debye-Sears effect set in motion the use of ultrasonic waves for many physical measurements. If a parallel beam of light is directed perpendicular to the path of ultrasonic waves in a liquid, the light is diffracted. The waves set up regions of strong compression and rarefaction in the liquid with different indices of refraction for light. These regions act as a phase grating and so give the diffraction images, from which it is possible to determine the sound wavelength and thus the velocity of the sound in the liquid. This measurement of velocity of the ultrasonic waves in a given medium by the method described and also by interferometric and pulse methods, enables various molecular properties to be determined.

Schneider and Burton[21] have shown that the rotating plate technique where the ultrasonic transmission is plotted as a

function of the angle of incidence of the waves, enables the velocities of dilatation and shear waves in plates to be determined. Details of the apparatus are given, and Poisson's ratio and mechanical modului may be determined. Methods for the determination of the elastic constants of both thermoplastics and thermosetting resins are given.

Natta and Baccaredda[8] measure the velocity of ultrasonic waves in various hydrocarbons and polymers, such as polystyrene, polyisobutylene and polythene. They found that the ratio of the ultrasonic velocity to the density of the polymers was related to the form of the molecules. In straight chain polymers, for instance, the ratio increases with increasing molecular weight.

Much other work has been carried out along similar lines to the above. A method has been described, for instance, for measuring the sound transmission along a filament of polythene and nylon, "Perspex" and "Neoprene."[22] Properties of sound waves in these various media are now being examined extensively and we may expect very important results to be obtained regarding structure of polymers. Not only this, but new tools are being produced for the study of sound and light waves, as well as the physical constants and mechanical properties of the polymers themselves.

Conclusions

From the literature which has already appeared there is no doubt that an unusual amount of research is being undertaken on the application of ultrasonic waves to high polymers and plastics. At the present time the work is confined largely to the laboratory, but all aspects of polymer science are being considered. In addition to this, however, some application has already been made in industry, the most important of which is that of materials testing, and there is no doubt that this very important technique is capable of great development and as was stated in the introduction, one large tyre company in America is already testing the whole of its output by ultrasonic methods.

In this article an attempt has been made to describe the basic principles of ultrasonics, and how these principles are applied to high polymers and plastics. Many other techniques than those described have been examined and no attempt has been made to give a list of them. Rather, it is hoped that the principles described will stimulate research workers and industrialists to investigate the use of ultrasonic waves in their organizations. These methods are undoubtedly new and there will probably be some conservatism in adopting them. They have been examined on a sufficiently large scale, however, to show that they have considerable promise and many manufacturers will undoubtedly solicit their use in future developments.

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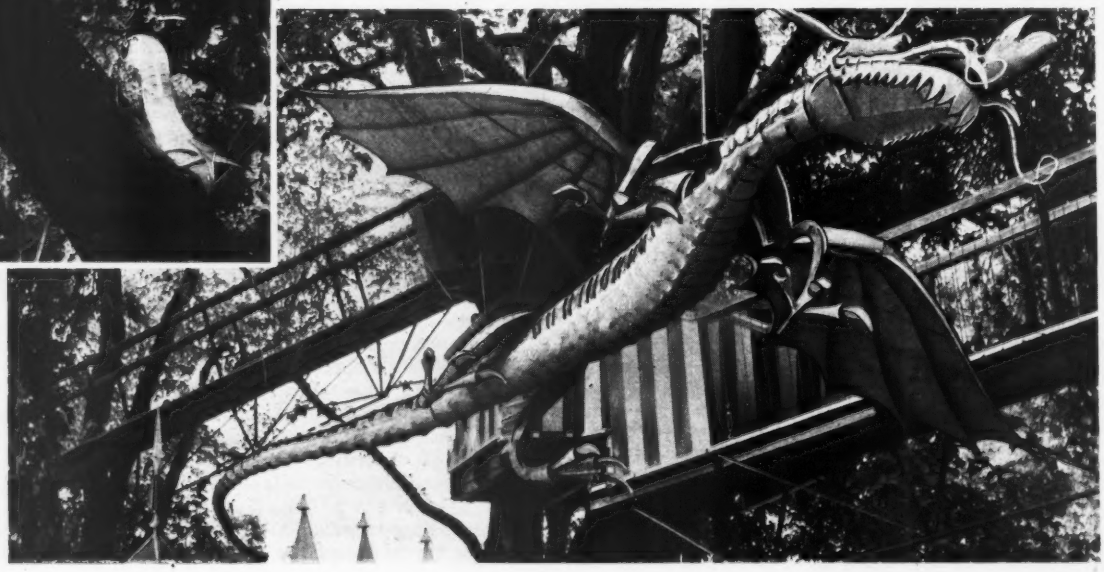
Looking Back on the Festival Gardens

VISITORS to the Festival Pleasure Gardens at Battersea, London, will remember the "tree-top walk," from the narrow footbridge of which were seen strange creatures suspended in the trees and illuminated internally. These creatures were constructed by Franco Signs, Ltd., 15-17, King Street, London, S.W.1, by spraying a wire framework with plasticized synthetic resin to which a "webbing" agent was added, and building up the resulting skin to a thickness meeting requirements. By this technique, the most complicated and fantastic shapes were readily produced. The caterpillars shown in one of the illustrations acquired a suggestion of movement by illumination one after the other in fairly quick succession starting at the bottom of the tree trunk. Similar models are being used for advertising and for theatrical use.



New Productions

Pressure Cooker Components

The side handles and the cover for the sealing and opening device on the "Prestige" pressure cooker (Platers and Stampers, Ltd.) are moulded in phenolic material by Ashdowns, Ltd., Eccleston Works, Knowsley Road, St. Helens, Lancs. Our illustrations show the actual mouldings and a general view of the cooker with the mouldings in position.

"Self-seal" Ash-bowl

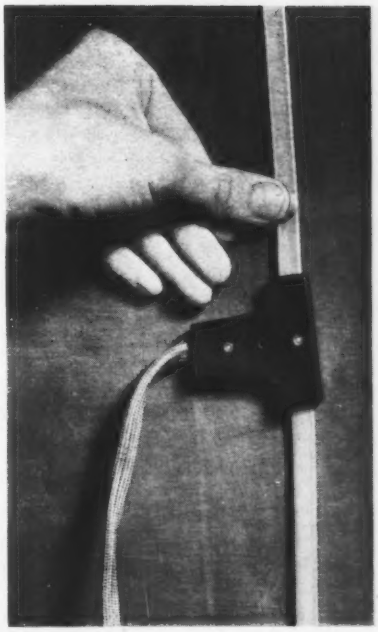
The "Self-seal" ash-bowl which Universal Metal Products, Ltd., Langley Road, Pendleton, Salford, Lancs, are moulding for Harwood Brothers, of Liverpool, is made from heat-resistant phenolic material. It consists of an upper ring, which screws on to the base, and a centre portion with four projections. The base has a hollow cylindrical tube in the centre, into which fits a metal rod with a screwed knob at the top, a spring being fitted between the top of the cylinder in the plastic base and the metal knob. The centre plastic portion rests on the top of the metal knob, so that when this centre part is pressed down with the finger, the ash and cigarette ends drop into the base out of sight. The ash-bowl is then easily emptied by unscrewing top and base. The dimensions are 4¾ ins. diameter by 2½ ins. high.

Television Aerial

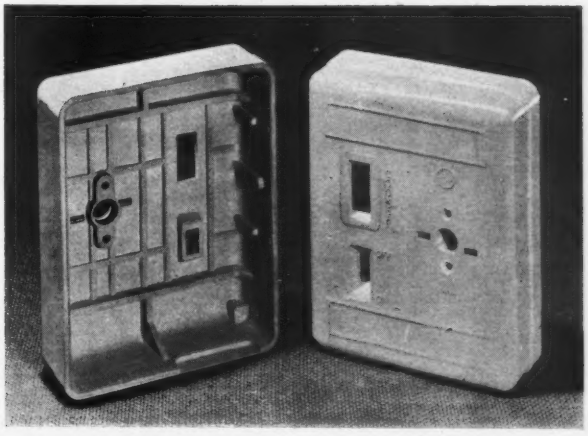
We saw this "flexible dipole" indoor television aerial at the recent Radio and Television Exhibition in London. Each element consists of a flat flexible conductor with polythene insulation. In use the aerial is unobtrusive and adaptable, and simple to install. It is merely fixed to the wall at the side of a door or a window (or wherever equally convenient), with as much as possible of the insulated conductor in a vertical position, and the rest of it running horizontally along the floor under carpet or linoleum, or along the skirting board. Special fixing tacks are provided, and these are driven through the centre of the polythene insulation. Two screened co-axial cables are used as "feeders" from the aerial to the set. These are in the form of polythene-insulated connectors screened with wire braid and sheathed on the outside by an extruded coating of p.v.c. The makers are E.M.I. Sales and Service, Ltd., Blyth Road, Hayes, Middlesex.

Cover for Cooker Control

The new "Wylex" control unit for electric cookers, incorporating 30 amp. D/P switch and ring main outlet, has a base and cover moulded from "Scarab" moulding powder, which was chosen for its excellent non-tracking properties. The moulding is by George H. Scholes and Co., Ltd., Wythenshawe, Manchester, who are makers of the "Wylex" range of electrical accessories. (Photo, courtesy British Industrial Plastics, Ltd.)



(Above) Flexible television aerial for indoor use, with polythene insulation.



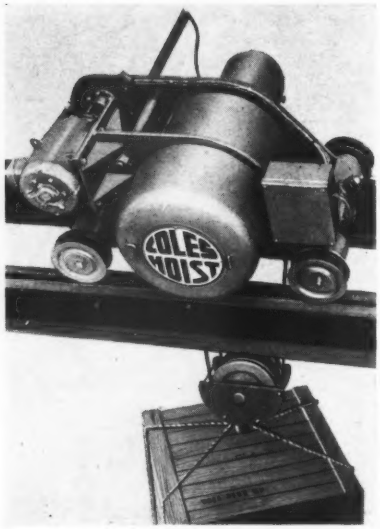
(Left) Cover for electric cooker control("Scarab").

(Above) Moulded components for pressure cooker (phenolic), also shown (right) in position on cooker.

"Self-seal" ash-bowl (phenolic).

PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes



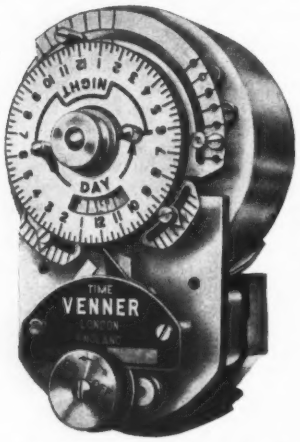
HOIST.—The "Coles" electric travelling crab for double girder cranes, by Steels Engineering Products Ltd., of Crown Works, Sunderland, has been designed to secure extremely low headroom. All the advantages of the "Coles" electric hoist are embodied. The machine-cut gear train runs in a sealed oil bath, is continuously lubricated, fool-proof and dust-proof. The large diameter, grooved hoisting barrel takes a full length of rope in one layer with ample reserve of spare turns on the drum. A rope guide feeds the rope accurately into grooves on the hoisting barrel and prevents overriding. Self-resetting limit switches can be readily adjusted to cut-out in any desired position and positively prevent over-hoisting and over-lowering. An automatic electro-mechanical brake holds the load immediately the current fails or is cut off. The crab can be operated by a push-button control suspended from the unit, from a fixed position, or from a control cab on the crane. Travel speed is 110 ft. per minute.

BALLS FOR GRINDING MILLS.—By arrangement with Mottola-Cully, of Milan, R. H. Cole and Co., Ltd., 2, Caxton Street, Westminster, S.W.1, are introducing to the British market the range of "Steatite" products manufactured by Steatit-Magnesia A.G., of Lauf-Holbrunn-Porz, Germany.

It is an established practice on the Continent to use steatite balls of varying sizes in ball mills. These balls are manufactured from soapstone by a special process which produces a material practically diamond hard and of very high density. They last longer than the normal pebble or steel ball bearings, are quite inert to chemical reaction, and will not powder or break up, so that finished products are uncontaminated. The steatite balls are manufactured in exact sizes varying between 8 mm. and 80 mm.—fifteen sizes in all.

LONDEX, LTD., 207, Anerley Road, London, S.E.20, makers of electrical equipment for remote control, inform us that they are extending their manufacturing facilities. After their Anerley factory proved inadequate for the continually increasing demand for the company's products, a second factory was opened two years ago in Penge. Now that this factory has been fully extended a third factory has been acquired in Croydon. As a consequence, it is hoped that there will be a considerable reduction in delivery time to customers, both at home and abroad. The main offices and research section remain at Anerley (Telephone: Sydenham 6258), and the progress (delivery inquiries) and buying departments at Penge (Telephone: Sydenham 2431).

TIME SWITCHES.—The new Venner T.J.S.P. time switch, a production of Venner Time Switches, Ltd., Kingston By-pass, New Malden, Surrey, is described in a leaflet (T.S. 27) which we have received. Its main features are low running and maintenance cost, a spring reserve of eight hours minimum, an automatic synchronous motor



wind, solar or hand-set dials, and plug-in switch unit. The compact overall size, $4\frac{3}{16}$ ins. by $4\frac{3}{16}$ ins. by 7 ins., makes this switch particularly suitable for applications where space is restricted. The clock cannot be overwound or strained by excess power from the winding unit.

SUNVIC CONTROLS, LTD., inform us that consequent upon the ever-increasing demands for their products, they have acquired a new factory on the industrial estate at Harlow New Town. The works and offices previously located at 132-135, Long Acre, have removed to Harlow, where production has already commenced. The sales department is now situated at 132-135, Long Acre, London, W.C.2, and inquiries and orders should in future be sent to that address. The registered office remains at Sunvic House, 10, Essex Street, Strand, London, W.C.2.

BLICK TIME RECORDERS, LTD., 188-190, Grays Inn Road, London, W.C.1, have sent us a leaflet relating to their watchman's control system which incorporates a new model clock which gives recordings from different stations in three colours if necessary to assist inspection of the record. A maximum of 78 stations may be recorded on time calibrated tape.

BARREL POLISHING THERMOSETTING PLASTICS.—Procedure for barrel polishing compression-moulded and cast thermosetting plastics, using "Lacrinoid" polishing cream No. 10, is outlined in a leaflet issued by Lacrinoid Products, Ltd., Gidea Park, Essex. The equipment required comprises hard wooden shoe pegs and/or wooden cubes of varying sizes, a rotating eight-sided wooden barrel with two compartments, a dumping box (used when emptying the barrel), a screen box (for separating polished articles from pegs), and a hot water tank.

In preparing the barrel for use, each compartment is loaded with 56 lb. of pegs and a hot mixture of $1\frac{1}{2}$ lb. liquified "Lacrinoid" polishing cream and $\frac{1}{2}$ lb. turpentine or white spirit. The barrel is then closed and rotated for two hours at 28 to 30 r.p.m., when it is ready to receive a batch of articles. The success of the method depends on the cleanliness of the equipment and articles to be polished; the latter must be dry, and free from grit or dust. At no time should the barrel be loaded to more than two-thirds of its height; for a barrel 36 ins. long by 30 ins. diameter, 56 lb. of polishing pegs and the same weight of articles constitute a convenient load. Standard barrelling time varies between 8 and 12 hours, the solid cover being replaced by the screen cover for the last hour in order to allow air to circulate and give a brilliant gloss.

The polishing pegs, sorted by screen from the finished articles, can be used about 15 times before cleaning becomes necessary. For a second run, 6 oz. of polishing cream and 1 oz. of turpentine or white spirit are needed, these quantities being reduced with each successive run until, finally, no addition may be necessary. When cleaning becomes necessary, the pegs are boiled in strong washing soda solution for 30 minutes, rinsed and washed in hot water, and then thoroughly dried; other methods of cleaning are also available.

MELAMINE.—Specification SS-I-B, issued by the Chemicals Division, British Oxygen Co., Ltd., Vigo Lane, Chester-le-Street, Co. Durham, relates to melamine. It includes methods of analysis for loss on drying, ash, pH, and assay.

COLOURING FOR POLYSTYRENE.—Additional manufacturing facilities for dry colourants for the colouring of crystal polystyrene and other thermoplastics have been announced by Mid-American Plastics, Inc., Cleveland, Ohio, who have purchased the rights and formulas of the Dry Color Division, H. Jamison Co., New York City. Dry colouring produced by Mid-America Plastics is known as "Colorblende," and is available in 17 colours, matching colours of the Bureau of Standards.

IMPORT LICENSING.—The Board of Trade announces the following amendment to the schedule of goods which can be imported from any country on Open General Licence, as set forth in Notice to Importers No. 458:—"Leather, dressed, and imitation leather, and manufactures thereof" (Group 16) to be deleted.

Regarding applications for import licences during the period ending June 30, 1952, Form I.L. B/A (Revised) is to be used for the following goods:—"Transparent cellulose wrappings and articles made of transparent cellulose"; "trunks, bags, wallets, pouches and other receptacles made wholly or mainly of material, not being leather but resembling leather, whether fitted or not."

The Editorial Offices of "Plastics" have removed to 27, Shaftesbury Avenue, London, W.1. All communications to the Editor should be sent to this new address. The telephone number is Gerrard 4406 (6 lines). The Advertisement Department is remaining at the Head Office of the Publishers, Temple Press Limited, Bowling Green Lane, London, E.C.1.

T.C.F. OF CANADA LTD., with registered offices and plant at Cornwall (Ontario), has been formed to manufacture transparent cellulose film and other packaging materials. The company is closely associated with British Cellophane Ltd., producers and exporters of transparent cellulose film, who will be one of the shareholders. The majority shareholders in the new company will be Courtaulds Ltd., manufacturers, by the viscose process, of rayon and other products since 1904. The initial annual output will be about 7,000,000 lb.

ERINOID, LTD.—The 36th annual balance sheet and accounts, for the year ended July 31, 1951, report net profit for the year (before provision for taxation), £168,457, as against £98,463 for the previous year. The major problem with regard to the company's operations during the year, has been the supply of raw materials necessary to maintain production.

The chairman's statement refers to his statement of last year, when stockholders were advised that Styrene Products, Ltd., the company jointly owned by Petrochemicals, Ltd., and Erinoid, Ltd., had commenced production in October, 1950, and adds that since that time production has proceeded regularly, and subject to raw materials being available the plant has produced the quantity and quality of polystyrene for which it was designed. The year for Styrene Products, Ltd., ends on June 30 and, although the company has only been working effectively for something over seven months, it is making a satisfactory profit. Accounts have not yet been completed, but it is not intended to transfer any of the profits to the parent companies in respect of the first period of trading.

In March last a statement was issued with reference to Erinoid's joint venture for the production of acetate flake at Lancaster in conjunction with Nelson's Silk, Ltd., a subsidiary of James Nelson, Ltd., of Nelson, Lancs., and Hercules Powder Co., Ltd., a subsidiary of Hercules Powder Co., of Wilmington, Delaware, U.S.A. In the meantime, some units of the plant have been put into operation and have so far fulfilled all expectations, and the company have every reason to believe that they will obtain a high grade acetate flake at a satisfactory price.

Export trade for Erinoid, Ltd., has continued to expand during the year under review and is a record in the history of the company.

This new exhibition room of Aero Research, Ltd., at Duxford, Cambridge, provides information on the uses of synthetic resin adhesives. For example, "Aerolite" urea-formaldehyde resins have applications in plywood manufacture, veneering, boat-building, wooden aircraft and motor vehicle structures, as well as general joinery. Various display items show how "Redux" is used to bond metal to metal, wood, thermosetting plastics, rubber and friction linings, while "Araldite" (for metals and ceramics) is featured as adhesive, surface coating, casting resin and cold-setting filler. Separate panels illustrate resins for wet strength paper and for the manufacture of sand-cores for foundries.

CATALIN LTD.—Net trading profit for the third quarter, ending September 30, 1951. is £14,642; when added to the profit of £22,688, for the first six months, this provides £37,330 for the first nine months of 1951, compared with £17,840 for the corresponding period last year. This profit has been achieved by a general increase in volume contributed to substantially by the company's Industrial Division. The chairman's statement to shareholders states that the company would have shown better results had they been able to obtain adequate supplies of suitable raw materials.

MR. PETER COLE, newly appointed director of R. H. Cole and Co., Ltd., is visiting Canada on business in connection with raw materials for paint and plastics.

BRITISH MOULDED PLASTICS inform us that Mr. B. A. Ensell has resigned from the Board as and from October 31, 1951, and is no longer connected with the National Plastics Group.

MONSANTO CHEMICALS, LTD., announce the appointment of Mr. Gilbert Dodd as deputy manager of their Purchasing Department. The appointment becomes effective on January 1, 1952, when Mr. Dodd will transfer his office to the headquarters of the Company's Purchasing Department at Abford House, Wilton Road, S.W.1.

NEW TAR ACID REFINERY.—Monsanto Chemicals, Ltd., and The Midland Tar Distillers, Ltd., jointly announce that a tar acid refinery is in course of erection at the new works of The Midland Tar Distillers, Ltd., Four Ashes, near Wolverhampton. Crude tar acids produced by Midland Tar Distillers will be refined at the new plant.

MR. F. W. COPELAND, chairman and managing director of Copeland and Jenkins, Ltd., is on a visit to the United States to study various aspects of development in the mica and plastics fields. Copeland and Jenkins Ltd. is one of the National Plastics companies, and Mr. Copeland is a director of the parent Board as well as of the operating companies, British Moulded Plastics, Ltd., and Moulded Products, Ltd.

"ARALDITE" RESINS.—Because of their special interest to users of synthetic resin adhesives, we reprint the accompanying tabulated data relating to "Araldite" resins. They were arranged by Dr. J. B. D. McKenzie in connection with demonstrations at the Special Summer School recently-organized by Aero Research, Ltd., and held at Cambridge.

Resin	Pot Life	Hardner	Per Cent. by Weight Hardner	Curing Time
Araldite 101	1 hour	951	7.14	24 hours at 20—30°C.
Araldite 102	4 hours	951	5—7	24 hours at 20—30°C. (Allow 1 hour for solvent evaporation before making join.)
Araldite Cold Setting Filler	1 hour	951	6	2—3 hours at 50°C. or one day at room temp. (not satisfactory for stoving).
Araldite D Casting Resin	1 hour	951	8—10	2—3 days at room temp. (may be cast at 100°C).
Araldite G Casting Resin	With Hardner about 1 week	911 (solid)	35	Warm to 70°C. Add Hardner, allow to stand 24 hours then cast. Cure at 160°C. max. for 5—6 hours.

N.B. In the uncured state all of these resins may be removed from brushes by washing in ethylene dichloride. The cured resins, in general, cannot be removed.

FORTHCOMING MEETINGS

Dec. 19.—"Recent Developments of Unsaturated Polyester Resins." E. Bader (Scott Bader and Co., Ltd.). Plastics Institute, Southern Section.

1952

Jan. 8.—"Ion Exchange Resins." K. W. Pepper. Plastics Institute, London Section. Waldorf Hotel, Aldwych, London, W.C.2. 6.30 p.m.

Jan. 15.—"Recent Developments in P.V.C." G. P. Lee (I.C.I., Ltd., Plastics Division). Plastics Institute, Scottish Section, and Institute of the Rubber Industry. At Institute of Engineers and Shipbuilders in Scotland, at 7.30 p.m.

Machines for the Industry

Herbert-Reed-Prentice Injection Machine

The Herbert-Reed-Prentice 10D 8-oz. injection moulding machine is manufactured in this country by T. H. and J. Daniels Ltd., Stroud, Glos, under licence granted to Alfred Herbert Ltd., Coventry.

THE Herbert-Reed-Prentice 10D 8-oz. machine provides plastics moulders with versatile means for general-purpose injection moulding. It is entirely self-contained and hydraulically operated throughout, with provisions for full automatic, semi-automatic or manual operation.

The base of the machine forms the oil tank of 70 gallons capacity (1), from which the hydraulic system is supplied by one Vickers double high- and low-pressure vane-type pump with "start" and "stop" push-buttons (9). Hydraulic cylinders operate the toggle and injection motion, control being effected by 4-way pilot-operated valves. These pilot valves are solenoid operated. An additional solenoid valve permits simultaneous use of full volume of combined high and low pressure, to ensure a fast injection stroke at high pressure. A separate handwheel-operated valve (6) controls variation in pressure. A stop valve (11) controls the speed of the moving die-plate, this feature being particularly convenient for setting-up the moulds.

The die-plates, measuring 21 ins. by 25 ins., both have a series of tapped holes arranged in a formation to provide adequate clamping facilities for the mould. The toggle mechanism (2), which provides a positive die-locking force of 250 tons, is a double shear link type, constructed of cast-steel members and alloy steel toggle pins operating in hardened steel bushes, all moving parts being automatically lubricated. The entire toggle mechanism is adjustable by hand-operated screw and nut, permitting accurate setting-up and adjustment for mould thickness.

Due to thermoplastic materials being poor conductors of heat and very sensitive to temperature variations through comparatively narrow margins, this machine is fitted with the new "Reed-Prentice" resistance-type heating cylinder (3) which provides three zone heating with adequate control arrangements. Heat is provided by eight heater bands distributed throughout the length of the heater body; they are thermostatically controlled by two Cambridge visual-type regulators (26, 27, Fig. 3). These regulators can be set at any required temperature to suit the type of moulding material used and the part being moulded. Individual control to the nozzle heater (21) is provided by a high, low or medium switch on the heat control panel.

All operating push-buttons, together with motor pump control and cooling water valves are located centrally at the front of the machine for the convenience of the operator. For full or semi-automatic cycle the operation is electrically controlled through four electronic timing units (28, Fig. 3), three of which are adjustable from 1 to 90 seconds. Three of these timers (A, B, C) control the time the injection plunger maintains pressure on the plastics material, the time allowed for the material to solidify in the mould after the injection plunger has returned, and the time the mould remains open for the ejection of the finished moulding. The fourth timer (D) controls the length of time the combined output of both high and low-pressure pumps deliver at high pressure. This timer has a maximum setting up to 10 seconds, and a minimum of 0.6 seconds. The timing device is initiated by the closing of the die making contact with a limit switch (13).

The Cambridge regulators, which provide the automatic heat control, together

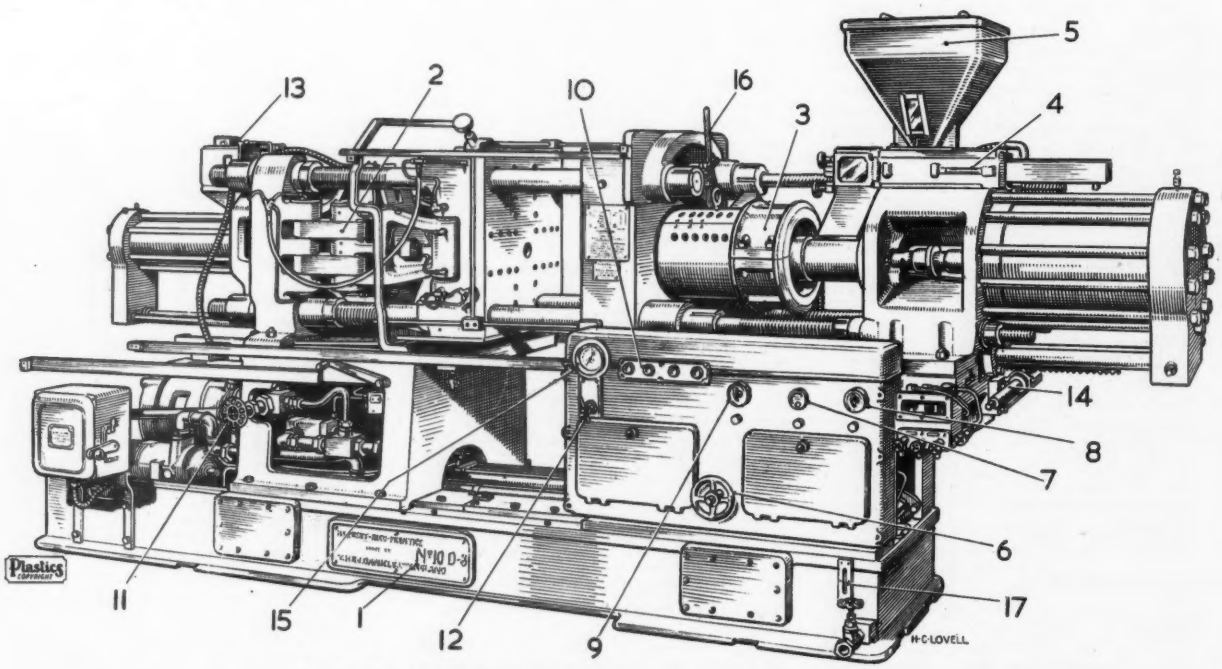


Fig. 1.—The Herbert-Reed-Prentice 10D 8-oz. injection moulding machine.

1.—Oil tank (70 gal.) in base. 2.—Toggle link mechanism. 3.—Heater. 4.—Moulding powder metering device. 5.—Feed hopper. 6.—Pressure control valve to injection plunger. 7.—"On" and "off" switch. 8.—Single and continuous cycle switch. 9.—"Start" and "stop" push-buttons for pump. 10.—Control push-buttons. 11.—Valves for adjusting speed of die movement. 12.—Shut-off cock for pressure gauge. 13.—Limit switch. 14.—Rack and pinion. 15.—Pressure gauge. 16.—Heater clamp lever. 17.—Oil level window.

with timers, and control relays, are assembled in a separate floor-mounted panel (Fig. 3).

It should be appreciated now that the sequence of operations on fully automatic cycle is continuous, but on semi-automatic (single cycle) the mould has to be closed by pressing a push-button, then the remainder of the cycle is controlled automatically by the timers. When operating on manual cycle the sequence of operations is controlled by push-buttons (10).

The plastics material to be used is contained in a hopper (5) of 50 lb. capacity and is fed through an adjustable gate in front of a feed piston which moves forward at every stroke of the injection plunger. The material is pushed over the edge of the chute and down to the feed cylinder. The amount of the material fed is determined by the position of the feed piston, which can be adjusted by a nut. Once this nut has been set the feeding mechanism is self-adjusting. If too much material is fed into the heating cylinder, the stroke of the injection plunger and the feed piston is reduced, which results in the quantity of material fed during the next stroke being reduced. Alternatively, if insufficient material is fed into the cylinder, the injection stroke is longer, resulting in an increased quantity at the next stroke.

Hydraulically interlocked sliding doors at the front and rear of the machine adequately safeguard the operator. The dies will not close until both of these doors are closed. Should either door be opened during the cycle it will cause the dies to open instantly and remain open until the door is closed.

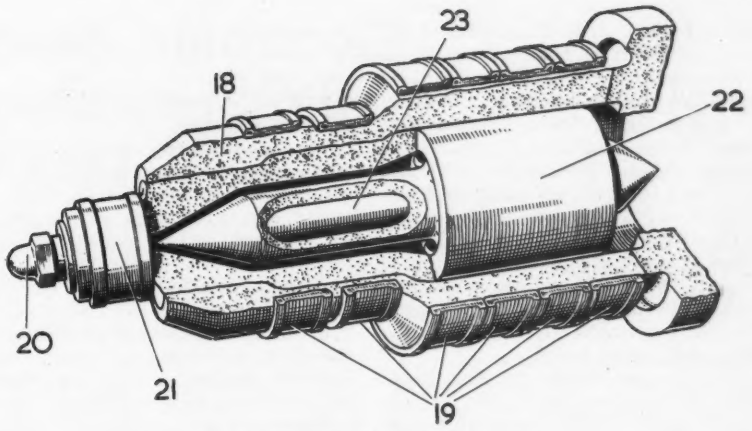


Fig. 2.—Details of injection cylinder.
18.—Heater body. 19.—Heater bands. 20.—Nozzle. 21.—Nozzle heater band. 22.—Torpedo spreader. 23.—Copper core.

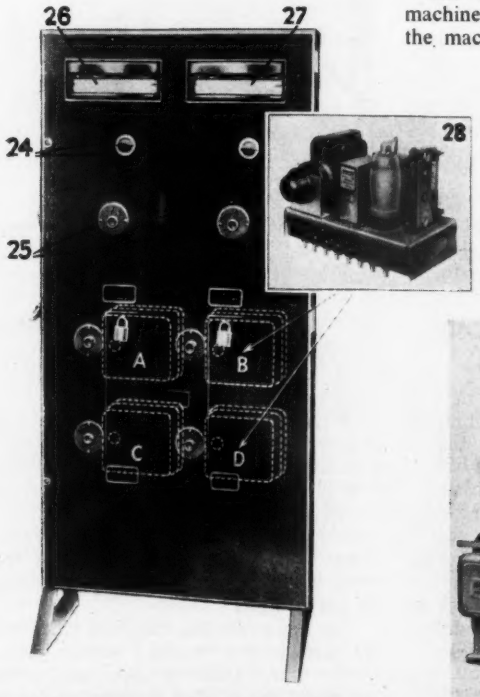
The machine has a plasticizing capacity of 45 lb. per hour. The injection plunger, which is 2⅜ ins. diameter, exerts 20,000 lb. pressure per sq. in. on the material being moulded. The maximum projected area which can be moulded is 100 sq. ins. and the maximum weight up to 8 oz. per shot (if moulding in cellulose acetate). Maximum and minimum die space is 16 ins. and 6½ ins. respectively.

The various operations to work the machine are very simple. Assuming that the machine has the mould in position and is being started from cold with the heating cylinder full of material, adjustments are first made to the pyrometers. The front pyrometer is set as low as possible, the rear one to the normal operating temperature and the heating is then switched on. After the rear pyrometer has reached and remained for approximately 10 minutes at the set temperature, the front one is adjusted to normal temperature and the nozzle heat turned on. Once the heaters have reached operating temperature, the injection pressure should be adjusted as required and the nozzle (20) checked to ensure that it is seated correctly in the mould bushing.

One hour is usually required to bring heaters to normal operating temperature, before the machine is set in operation.

To the right of the main push-button controls (10) are the electric switches. The first switch (7), marked "Off-On," controls the power supply to the panel; the second switch (8) selects the type of automatic operation required.

(*Continued on page 358*)



24.—Zero setters. 25.—Indicating lights. 26.—Front Cambridge indicating regulator. 27.—Rear Cambridge indicating regulator. 28.—Four timers.

Fig. 3.—Control panel, with (inset) one of the four timers indicated in positions A, B, C and D.

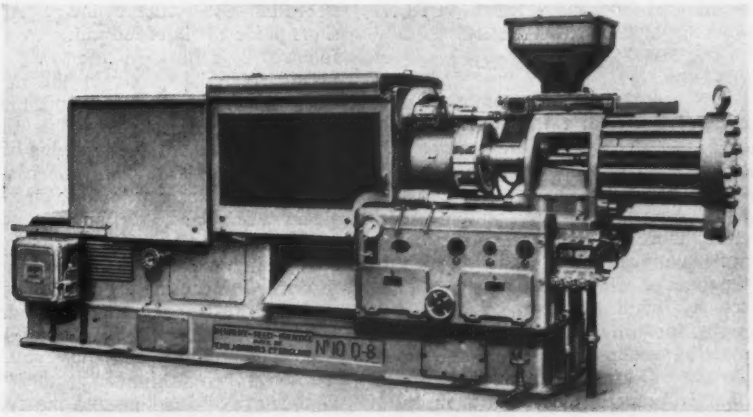


Fig. 4.—General view of Herbert-Reed-Prentice 10D-8 oz. injection moulding machine.

Electronic Seamer

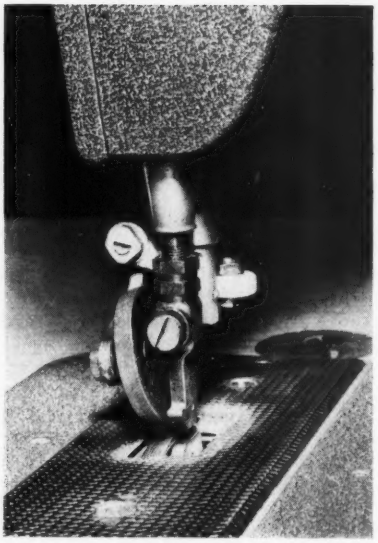
A NEW electronic seamer introduced by the Singer Sewing Machine Co., Ltd., Singer Building, City Road, London, E.C.1, will bind-seam, tack and spot seal almost any thermoplastics material at finger-tip controlled speeds.

The machine deals equally well with straight or curved seams, also sharp corners, and starts and stops instantly without affecting the quality of the seam, which is permanent, water-tight and air-tight, and almost invisible.

The movement of the machine treadle automatically operates a micro-switch which supplies high-frequency current to the electrodes only whilst the machine is running, thus preventing damage being caused to the plastics material when the machine is stopped.

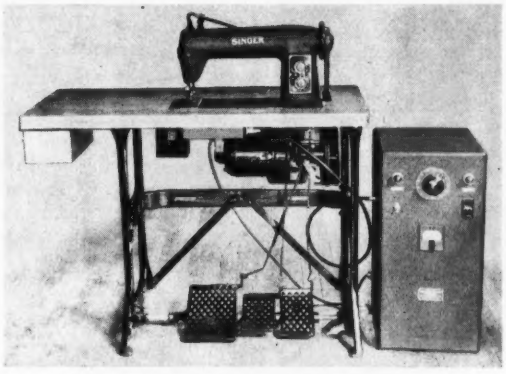
The high-frequency current is supplied at 62 megacycles per second, and the oscillator has an output of 150 watts. A tuning unit is provided on the bed of the machine, which enables the high-frequency circuit to be brought into resonance regardless of the type and thickness of the plastics sheet being bonded. The provision of a switch which can supply high-frequency current to the electrodes without running the machine permits tacking or spot welding.

The machine is capable of bonding thermoplastics material up to 0.025 in. thick, at speeds over 25 ft. per minute.



Singer electronic seamer: close-up view of the electrodes.

Singer electronic seamer in use.



General view, showing transformer.

HERBERT-REED-PRENTICE INJECTION MOULDING MACHINE

(*Continued from page 357.*)

To operate "semi-automatic" (one cycle), the selector switch (8) is set at the marking "one cycle"; the power switch is then turned to the "on" position. The cycle is commenced manually, by pressing the "die closed" push-button, which closes the dies. The remainder of the cycle continues automatically through the timer units, which have been previously set by hand. The injection plunger moves forward and forces the hot molten material under pressure into the mould cavities. During the forward movement of this plunger the fixed quantity of plastics material is fed from the feed sleeve into the heating cylinder. After a short pause the injection plunger returns, followed by a further pause to allow the plastics material to set in the moulds. Then the mould opens, and the finished moulding is ejected by the ejector mechanism located in the moving half of the mould. This mechanism consists of a series of ejector pins fitted to an ejector plate, which possesses an arm which locates a stop at a given point during the die-opening and pushes the ejector plate forward, thus causing the pins to eject the moulding. Arrangements are made for a return, ready for the next cycle.

For the fully automatic cycle, the selector switch (8) is set at the "continuous cycle" marking and the cycle is commenced by turning the power switch to "on." The cycle is automatic throughout; the dies close automatically after each cycle until the power is switched off.

When operating by manual control, the power switch must be in the "off" position and the whole cycle is then controlled by push-buttons, the time pauses being left to the operator. The push-buttons on the left of the control panel operate the opening and closing of the mould; those on the right, the actuating of the plunger.

The thermoplastics materials which can be used on this machine include p.v.c., polystyrene, cellulose acetate, nylon, polythene, etc. When moulding nylon, a specially designed self-sealing nozzle is used.

Successful Designing for Plastics Moulding—XXVII

By W. M. HALLIDAY

This instalment describes further insert design and application features, with special reference to wire, plate and sleeve type inserts, and their preferable anchoring provisions to obtain satisfactory fixture.

IN the preceding article in this series some consideration was devoted to the subject of inserts, and the various design factors and anchoring requirements, together with preferable forms associated with the use of stud and screw insert components. Inserts of this kind, required to provide fastening facilities in the main, are, of course, very extensively employed with both compression and injection forms of moulding.

One of the chief factors leading to their adoption is the relative cheapness and simplicity of application, due to the fact that generally studs and screws of standard size and form may be employed without necessitating any appreciable or expensive amount of re-machining to obtain successful anchorage of the parts in the wall of the moulding. A great many other types of inserts are, however, habitually used by the plastics moulder to impart different qualities and features to the moulded article, or to give increased facilities in some particular direction, with the minimum amount of trouble and expense. For instance, small-diameter metallic wire may often be employed to very great advantage, particularly when such items may be made up as short pieces formed to a given shape, such as a clip, fastener hook or latch, staples, springs, etc.

On the other hand, metallic plates of requisite thinness and usually having considerable flexibility may also be adopted, to provide additional bracing to portions of a moulding which have to bend a certain degree during use. Similarly, plates in copper, brass and other excellent electrical conducting materials are extensively used as insert components with mouldings required for electrical purposes, etc.

Hollow bushings or sleeves—in a variety of metals and alloys—having threaded, splined or specially formed hole shapes, often of an unusual and sometimes irregular contour, are frequently employed to incorporate some fastening, or bearing feature in the moulded product.

As a general rule these objects will be achieved by the introduction of a suitable insert piece, in a manner not readily or inexpensively possible by direct moulding of the particular shape into the plastics material, or by subsequent machining of that material. Furthermore, the ability to employ these additional common forms of insert components will afford the mould designer a considerable degree of flexibility and much wider choice when selecting or developing mould design forms, and economical component designs. Moreover, their use will frequently be the means of deriving innumerable economies, both in production and advantages in respect of features, and more simple forms possessed by the finished moulded article.

In very many cases, adoption of such inserts will permit a more simple mould construction to be employed which, in turn, despite the little extra time required for mounting inserts in position, will ensure speedier manipulation of the mould, and an increased rate of production therefrom.

In this present article, detailed consideration will be given to the several important problems and design points connected with the preferred application, location and anchorage of inserts. Various typical forms of wire, plate and sleeve inserts will be described and illustrated to indicate certain undesirable, and some preferred, forms.

Wire Inserts

As a general rule inserts of this character will be chiefly used to stiffen or strengthen some relatively weak or unsupported portion of a moulding, especially when such wall portion has to be flexed or bent to a considerable curvature during normal service use. On the other hand, wire insert components, when formed to a suitable shape, may be readily moulded into the wall of an article to act as a fastening device, by clipping, or by friction of spring action on the mating member to be attached.

The greatest practical facilities will be attained by using standard diameter cylindrical metal wire, although other cross-sectional shapes, such as square, hexagonal or polygonal, etc., may be used with advantage to meet specific special requirements.

The reason why ordinary round wire is to be preferred wherever possible, is because of the greater ease afforded the mould engineer in fashioning the requisite housing holes in the mould within which the wire insert has to be located during the actual moulding cycle. Round wire requires only a simple form of cylindrical housing hole, which may be drilled and reamered very quickly and inexpensively by ordinary methods. Use of round wire after this fashion will also greatly simplify mounting operations for the mould operator.

With square, hexagon and similarly shaped wire inserts, however, additional difficulties will usually be experienced when machining the housing holes in the mould cavity, etc. These must, of course, be very accurately shaped and sized to conform to the wire shape and avoid undesirable clearances between hole and sides of wire, along which plastic material may leak during flow or injection.

Thus, when specifying the introduction of wire inserts, to ensure simplest mould constructions, lowest cost, and absence of flashing on the finished part, every endeavour should be made to make use of ordinary standard diameter round wire. Unfortunately, very small diameter wire will generally have to be employed with such insert parts, owing partly to the limited cross-sectional thickness of walls to be buttressed by the embedded wire, and partly to the desire to maintain the total weight of the finished moulding as low as possible.

Furthermore, since many inserts of this kind will have to be pre-formed (by bending, etc.) into quite intricate shapes, a very soft grade of metallic wire will usually have to be employed. This requirement, coupled with the necessarily small diameter, will frequently result in such an insert component having relatively low mechanical strength, poor rigidity, and a considerable degree of pliability when in its free state prior to moulding into place.

As a result of the introduction of inserts of this nature, which will, of course, be subjected to heavy flowing pressures and frictional drag arising with many of the stiff synthetic compression-moulding plastics materials, the inserts may easily deflect, distort or become permanently bent from their proper position and initial correct form and shape.

To a lesser extent with injection moulding, a fragile wire insert will be subject to pressure and drag, especially if such a slender piece is located directly athwart the main incoming stream entering the mould cavity. Usually, however, with injection moulding the pressures will be much less, and the friction occurring between the insert and the near-liquid injected stream will be nothing like as severe as with compression moulding.

The injection mould designer will also often be able to minimize such undesirable working conditions by adapting the

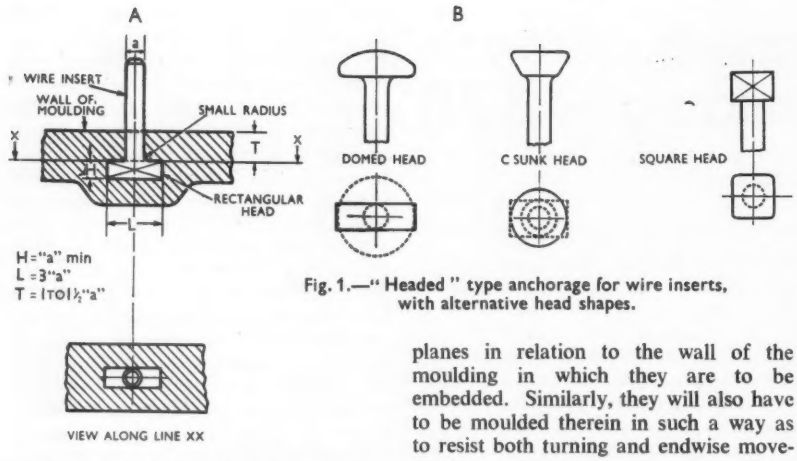


Fig. 1.—" Headed " type anchorage for wire inserts, with alternative head shapes.

runner-gate feed in such a manner that the insert will not lie in the path of the main stream, or at points where the greatest turbulence is to be expected.

To overcome the aforementioned disadvantages, and for the reasons explained, modern moulding practice increasingly inclines towards confining the use of such soft wire inserts with injection and transfer types of moulding rather than with compression. Flow pressures and frictional drag can be more easily controlled and are generally much less with the former moulding techniques, and thus will be much more suited for dealing with delicate insert components.

Formation of Wire Inserts for Effective Anchorage

With the application of soft metallic wire inserts, one of the chief questions to be satisfactorily settled at the mould-designing stage is the particular manner in which the parts will be located and anchored within the moulded wall of the article. As with stud and screw type inserts, wire insert components will generally have to be located along two planes in relation to the wall of the moulding in which they are to be embedded. Similarly, they will also have to be moulded therein in such a way as to resist both turning and endwise movements.

In general practice, and for most ordinary purposes, one of six common conventional forms of location and anchorage may be employed, and selection of the particular kind will depend upon the size and shape of the insert piece; the manner of mounting it in the mould, the magnitude of wall section, and whether that part is bossed, ribbed, etc.; and the character of the service duty to be performed by the moulded-in insert.

These six fixing forms are: (1) headed, (2) hooked or bent, (3) claw or looped, (4) flattened or snack head, (5) pressed or crimped head, and (6) knurled shank types. These various fixing forms and methods will be illustrated in the above order to show preferred features, and desirable proportions for insert formations, and surrounding wall sections of the moulded article.

The Headed Type of Fixing

The diagrams A and B (Fig. 1) depict one of the commonest arrangements adopted for obtaining very positive and secure retention of a soft wire insert member.

From diagram A (which shows the complete wire insert moulded into place in the wall of the component), it will be observed that a small head has been formed on the end of the wire, around which the plastics material will be moulded to prevent the wire from moving radially or longitudinally. The end of the wire has been formed with a rectangular-shaped head as shown, a formation being obtained quite inexpensively by cold-forging or pressing methods.

The respective sizes of such rectangular head formation should preferably bear a certain relation to the basic diameter of the wire if best keying results are to be derived. For example, the height H of the head portion should be made not less than the diameter 'a' of the wire. Where heavy lateral or pulling pressures will be imposed on the insert during use, this head dimension may usefully be increased to 1½ times diameter 'a,' to obviate all tendencies for the head portions to bend.

The length of the head as denoted by symbol T should be approximately three times dimension 'a,' whilst the thickness of wall T immediately below the head should be from one to 1½ times dimension ' a.' This latter is a most important provision as affording adequate safeguard against pulling out the insert during use. A too thin wall of material remaining at this point might easily result in the plastics material being torn away when endwise pressures are imposed on the insert.

All corners of the rectangular head should be slightly rounded, and a sufficiently large radius fillet left where the round shank joins to the underside of the head, as indicated in the upper diagram. This will reduce the liability towards cracking the plastics wall, and give a more durable fixture for the insert.

Various shapes of head may be employed, according to the size of the wire and forming facilities available. Some typical alternative head shapes are shown at B (Fig. 1), viz., the domed or mushroom head, the vee or countersunk head, and the square head.

The domed or mushroom head may be made circular in shape, as depicted by light broken line in lower plan view, or may be rectangular, having a width equivalent to the diameter of the wire. This formation can be obtained by

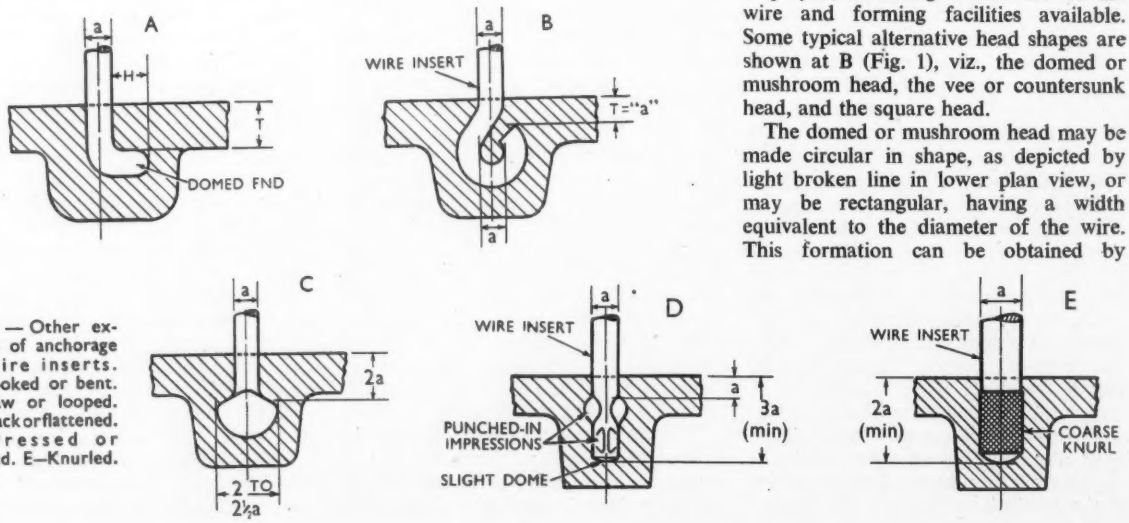


Fig. 2. — Other examples of anchorage for wire inserts. A—Hooked or bent. B—Claw or looped. C—Snack or flattened. D—Pressed or crimped. E—Knurled.

ordinary pressing or cold-forging of the wire, using very simple mushrooming dies and punches. Like the rectangular head shown at A, this second alternative ensures a very secure "key" for the insert, and should generally be adopted where heavy pulling pressures have to be imparted to the insert during use.

The vee or countersunk head, formed in a similar manner by pressing, etc., may again be rectangular, having a width closely approximating to the diameter of the base wire shank. Alternatively, the head may be formed conical, as shown in heavy continuous line in the lower plan diagram, but this formation will require a considerably greater amount of upsetting or forging of the wire, and will thus be somewhat more expensive to reproduce.

The squared head is another useful and much-applied method of fixing but, like the conical vee head, will best be applicable where relatively light pulling and radial pressures arise on the finished embedded insert.

With all these three forms an ample radius fillet should be provided at the junction between head and shank, and all corners should be rounded slightly, for the reasons already given in reference to example A (Fig. 1). The vee and square head forms of insert should also be moulded deeply into the wall of the component to derive the maximum resistance to endwise pulling pressures.

The Hooked or Bent Head

Diagram A (Fig. 2) illustrates a very typical common form of wire insert location and anchorage. This gives quite satisfactory retention of the insert, and possesses the added advantage of being much more easily reproduced at less cost than the rectangular head form described and illustrated at A (Fig. 1).

With this design formation the critical end portion of the metallic wire is simply bent, preferably at approximately right angles to the shank, as shown, although this is not vitally important. The plastics material in the wall is then formed around the bent portion and a certain length of the plain shank, to prevent the insert from turning or moving laterally in the solidified wall.

The extent of the hooked end portion, as denoted at H, should be made not less than the diameter of the wire to obtain best keying results. No flattening of the sides of the bent portion is necessary. The endface of the bent part should be well rounded rather than finished off square and with sharp corners, as this latter condition would be prone to cause cracking of the wall.

The strength of this form of fixing will be determined chiefly by the diameter and strength of the wire used. This will arise to a much greater degree than with the preceding form.

In designing the component moulding and the requisite wall section in which such insert has to be embedded, it will be advisable to dispose the hooked end of the insert somewhat deeper than is the case with the previous example A (Fig. 1). Thus the thickness of wall material immediately underneath the hooked-over end, as shown at T, should be from 1¾ to 2 times diameter 'a.'

The formation of the hook on the wire will be performed particularly simply generally by means of a simple bending jig, having a fixed peg of the necessary substantial diameter around which the wire will be drawn to the required shape. When bending, care should be taken to ensure an inner radius on the hook of sufficient size to prevent cracking or tearing the wire, which otherwise would become weakened.

The Claw or Looped Head

The third type of location and fixing of a wire insert, shown at B (Fig. 2), is extremely effective, strong and durable, and is specially suited for those cases where a considerable endwise pull is imparted to the insert. It will, however, prove rather more expensive to fashion such an almost full-circle loop or eyelet on the wire, particularly if the diameter is large.

With this form the critical end of the wire to be embedded in the wall is looped or bent in the form of an eyelet, after the manner shown. The plastics material is formed completely around the looped portion and the hole in the centre thereof will also be filled, thus giving very effective "keying" for the insert against rotational or lateral movements.

The diameter of the looped portion should approximate closely to dimension 'a,' this being reproduced by drawing the wire around a fixed cylindrical stud of 'a' diameter. This bending operation would be performed, of course, by means of a very simple manually-actuated fixture. It is not essential for the loop to be fully closed, but a slight gap may be left, after the manner illustrated. The thickness T of the wall material immediately above the looped portion should be made not less than dimension 'a' to prevent pulling out the insert during use

The Snack or Flattened Head

This form of fixing is illustrated at C (Fig. 2), and simply consists of pressing or squeezing out the end of the wire to form a flattened portion, of which the thickness will be very much smaller than the diameter 'a,' but the length will be considerably greater than the latter dimension. The maximum length of the flattened portion should be from 2 to 2½ times diameter 'a' to ensure best "keying."

By inserting the length of wire insert underneath a suitable simple type of percussion punch, the end will be easily drawn out, in the cold state, to produce a satisfactory shape of head. With soft annealed wire this operation will be particularly rapid and economical.

No strict limits will prevail in regard to the outline shape of this flattened head, providing the maximum length dimension is sufficiently greater than the basic shank diameter to give ample undercutting of the wall material in the manner depicted. It should also be specially noted that all these four styles of insert formation and fixing entail a considerable increase in the size of the wire at the point where it is embedded into the wall of the moulding. For this reason, the wall will usually have to be well bossed up, after the fashion illustrated.

The Pressed or Crimped Shank

With this kind of anchoring the basic diameter of the wire undergoes little increase in size, and therefore will be best applicable where the wall cannot be heavily bossed or ribbed, as with the previous examples.

With this style of fixing, D (Fig. 2), the shank of the wire is formed with two, four or more protruberances, formed generally in pairs diametrically opposed to each other. Such pairs of crimped formation may be distributed along the length of the wire, being disposed about 90 degrees apart, as shown.

The crimping will be effected by means of a simple dual punch-die set-up, of mechanical actuation to give most economical production speeds and costs. It will, in effect, form a series of raised fins around the wire, and commensurate hollows, which latter will be filled by the plastics material, thus arresting radial turning or endwise movement of the insert.

The length of the crimped portion should be made about three times diameter 'a,' whilst the thickness of the plastics wall from the surface to the first set of crimped formations should be maintained not less than dimension 'a.' For preference, the end of the wire should be rounded or domed.

The Knurled End Head

This type of insert fixing, depicted at E (Fig. 2), will in practice be found the least satisfactory for two main reasons, despite the fact that usually very little bossing support will be required on the effective wall section.

First, it will generally be somewhat difficult to reproduce a sufficiently coarse and deep knurl on the soft wire, because of its pliability. Such a knurl would probably best be formed on an expensive thread-rolling machine. Forming by ordinary roller tools in the centre lathe, etc., would be slow and objectionable.

(Continued on page 341.)

PATENT REVIEW

The following abstracts have been made from specifications at the Patent Office, with the permission of the Controller of H.M. Stationery Office. Complete Specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 2/- each.

B.P. 654,891. Appl. 13.7.48. Acc. 4.7.51.
Injection moulding machines for plastic material. To: Lester Engineering Co.

The injection cylinder has two co-axial bores with a solid and a tubular plunger. The tubular plunger acts as slide valve for the supply of the material and the movements of the plungers are timed to control the material supply.

B.P. 654,897. Appl. 20.9.48. Acc. 4.7.51.
Chemically resistant articles. F. K. Earp, A. E. Wiggs. To: Morgan Crucible Co., Ltd.

A dry moulding composition, from which accurately dimensioned parts for chemical and engineering plant may be made under pressure at elevated temperature, comprises a solid cashew nutshell resin polymer, a chemically resistant filler and an aldehyde or aldehyde-yielding substance.

B.P. 654,925. Appl. 31.5.46. Acc. 4.7.51.
Method of producing fibre-reinforced resinous parts and the product resulting therefrom. A. H. Stevens. Comm. from: Marco Chemicals Inc.

A fibrous base is prepared, cut, etc., in a dry state, then impregnated in a mould with a polymerizable resinous material in free flowing liquid state by pressure (or suction) sufficient to impregnate the base and to drive out all air entrapped therein. Flat and curved parts may be manufactured.

B.P. 654,955. Appl. 16.12.48. Conv. (U.S.A.) 26.12.47. Acc. 4.7.51.
Coating or impregnating fibrous cellulosic material with organic coating or impregnating agents. J. H. Daniel Jnr., L. H. Wilson, R. Hastings, C. G. Lands. To: American Cyanamid Co.

B.P. 654,957. Appl. 17.12.48. Conv. (U.S.A.) 26.2.48. Acc. 4.7.51.
Polymers and polymer products. R. F. Schmidt, A. E. Ardis, H. Gilbert. To: B. F. Goodrich Co.

The invention relates to high molecular weight polymers of vinylidene cyanide.

B.P. 654,997. Appl. 9.7.48. Conv. (U.S.A.) 22.8.47. Acc. 4.7.51.
Plasticized resin compositions. C. H. Alexander. To: B. F. Goodrich Co.

A vinyl halide polymer or a copolymer of a vinyl halide with other copolymerizable monomers is plasticized with certain phthalates.

B.P. 655,006. Appl. 21.11.47. Conv. (U.S.A.) 29.11.46. Acc. 4.7.51.
Manufacture of moisture-proof, heat-sealable films. To: British Cellophane, Ltd.

A film-forming vinylidene chloride interpolymer and an ester type wax (carnauba wax) coating act as slip agent for a regenerated cellulose base film (for packaging machines).

B.P. 655,131. Appl. 27.7.48. Conv. (Norway) 18.12.47. Acc. 11.7.51.
Clothes-peg. J. Hansen.

The peg may be made in one piece from plastic material by moulding.

B.P. 655,185. Appl. 22.6.48. Acc. 11.7.51.
Apparatus for the production of pellets of thermoplastic or thermosetting materials of the class known as plastics. R. Kris, A. M. Harrison. To: Welwyn Plastics, Ltd.

A "skin" of the material passes a pair of heating rollers and a pair of cooling rollers. One roller of the first pair is scored circumferentially, one of the second pair axially so as to form on the "skin" a reticulated pattern without cutting it. The pellets are separated by breaking along the grooves.

B.P. 655,233. Appl. 5.11.48. Conv. (Sweden) 5.11.47; 31.5.48. Acc. 11.7.51.
Tooth protheses. A. F. Rydin.

An artificial tooth has a facade of a synthetic resin (acrylate) with a socket of stainless steel.

B.P. 655,265. Appl. 2.10.47. Acc. 18.7.51.
Synthetic resins and stoving enamels. S. R. Finn. To: Nat. Res. Development Corp.

Phenol-formaldehyde synthetic resins are prepared by interacting phenol and formaldehyde at a molar ratio of between 1.1 and 1.8 in presence of an alkaline catalyst at room temperature. Useful for corrosion-resistant stoving enamels.

B.P. 655,297. Appl. 3.9.46. Acc. 18.7.51.
Shuttle guards for looms. W. B. Robertson, A. M. Reekie, W. D. Macintosh, H. H. Hunter. To: Hay and Robertson, Ltd.

Narrow strip of "Perspex" is set in a hinged frame.

B.P. 655,356. Appl. 12.12.46. Conv. (Switzerland). Acc. 18.7.51.
Moulding powders for production of moulded bodies. M. Haefeli.

Polymethacrylic acid esters are treated with solvents to remove the lower molecular components and deleterious inclusions. The resulting powders of homogeneous molecular structure are suitable for threads, films, sheets, coatings, particularly for heavily stressed bodies, such as dental protheses.

B.P. 655,358. Appl. 5.7.47. Conv. (U.S.A.). Acc. 18.7.51.
Moulds for vulcanization of rubber and heat treatment of other thermosetting materials. H. H. Deist, F. H. Mason. To: Firestone Tire and Rubber Co.

Mould sections of wood are combined with matrices of moulded sintered glass so as to be suitable for high-frequency dielectric heating.

B.P. 655,377. App. 12.7.47. Conv. (U.S.A.). Acc. 18.7.51.
Crystalline tetramethylene isophthalate polymer. To: Wingfoot Corp.

Linear polymers made by condensation of tetramethylene glycol and isophthaloyl chloride for textile fibres and also for moulded articles and electric insulations.

B.P. 655,523. Appl. 20.11.48. Acc. 25.7.51.
Emulsion polymerization of styrene compounds. H. M. Hutchinson. To: Distillers Co., Ltd.

Alkali metal and ammonium salts of monoesters of phthalic acid and its lower homologues with saturated aliphatic alcohols of 5-18 carbon atoms are effective emulsifying agents. Polymers obtained gave clear mouldings.

B.P. 655,524. Appl. 15.4.48. Conv. (U.S.A.). Acc. 25.7.51.
Interpolymers. To: U.S. Rubber Co.

Soluble, unsaturated polymeric materials for use as moulding powders, or dissolved for coating, impregnating, laminating compositions, are obtained by interpolymerization of a tri-2-alkenyl aconitate with a 2-alkenyl halide and styrene or a substituted styrene.

B.P. 655,533. Appl. 5.12.47. Conv. (U.S.A.). Acc. 25.7.51.
Stabilized age-resistant polymer compositions. To: Western Electric Co.

Certain accelerators of the rubber vulcanization are added together with sulphur to polyethylene for making moulded objects.

B.P. 655,534. Appl. 26.12.47. Conv. (U.S.A.). Acc. 25.7.51.
Cellulose esters. To: Brit. Celanese, Ltd.

Purified cellulose is pretreated with a mixture of proponic acid and formic acid. The cellulose proprionate thus obtained possesses high clarity, viscosity and stability for textiles, films, moulded articles.

B.P. 655,558. Appl. 7.11.46. Conv. (Australia). Acc. 25.7.51.
Injection moulding press. To: H. Dalton and Co. Pty., Ltd.

A hydraulic press for forming mouldings from powders ("plastic" mouldings, but also mouldings from low-melting point metals) is characterized by an injection plunger carried by the injection ram within the main hydraulic ram. Double-acting auxiliary rams are incorporated for nearly closing and for opening the die.

B.P. 655,583. Appl. 27.8.48. Acc. 25.7.51.
Sealing and severing tubes of thermoplastic material. W. T. Johnson.

The cutting (metal) jaw with a detachable knife blade, which may be heated, co-operates with a cutting block having a surface of a phenol formaldehyde resin.

B.P. 655,590. Appl. 17.9.47. Conv. (U.S.A.) Acc. 25.7.51.
Stabilizing halogen-containing organic compounds of high molecular weight. W. L. J. de Nie, H. T. Voorhuis. To: N. V. de Bataafsche Petroleum Maatschappij.

Polyvinyl chlorides are stabilized by ethers having boiling points above 300 deg. C. at normal pressure and are obtainable by reacting halogen-containing epoxides or poly-epoxides with glycerol or with (dihydroxydiaryl) alkanes.

B.P. 655,615. Appl. 31.10.46. Conv. (U.S.A.). Acc. 25.7.51.
Polymerizable compositions. To: American Cyanamid Co.

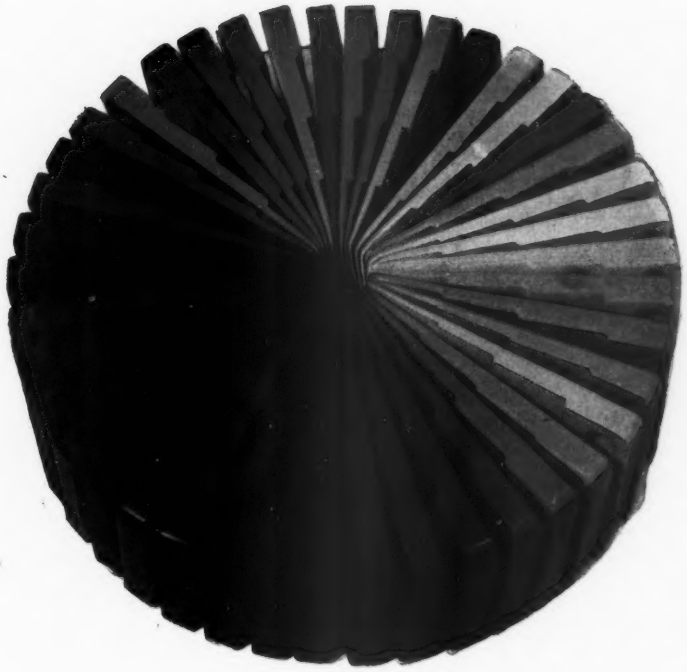
Coating, moulding compositions, moulded, laminated articles are made from unsaturated alkyd resins and one or more compatible monomeric substances containing an amide group.

B.P. 655,646. Appl. 24.8.48. Acc 25.7.51.
Manufacturing boxes and like containers of plastic material. W. F. Stahl.

Lids and bodies are formed from fusible tubes into which discs are inserted, the parts being united by heat and pressure in a continuous sequence of operations.

B.P. 655,655. Appl. 7.1.48. Conv. (U.S.A.). Acc. 25.7.51.
Optical systems for measuring the thickness of transparent sheet material. To: Brit. Celanese Ltd.

Interferometric methods are employed. An optical wedge whose thickness varies from its thinnest point to its thickest over a range including the thickness of the sheet, receives light reflected from the material. An interference pattern can be observed at the point of the wedge where its thickness equals that of the material.



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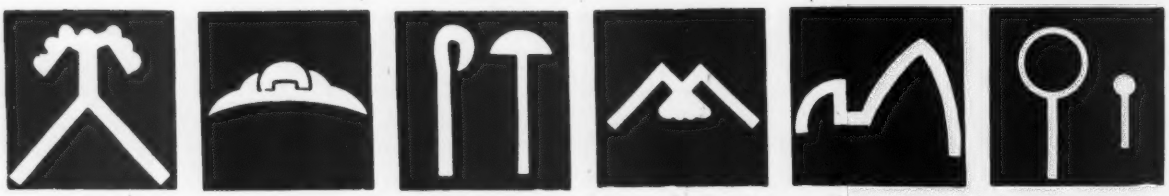

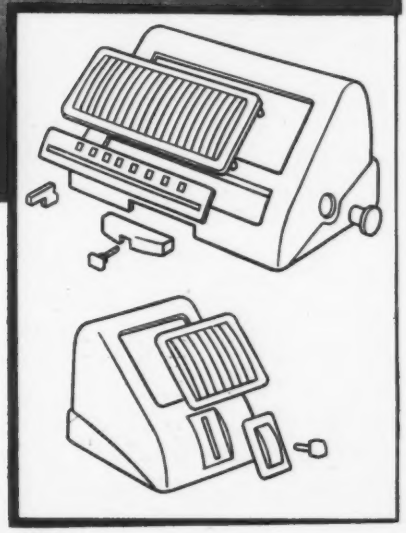

READERS may care to study another example of Insulators' moulding technique as illustrated in the "Loudspeakerphone". To ensure both functional efficiency and pleasing appearance four plastic moulding materials are used — phenolic, p.f. urea, methyl methacrylate and cellulose acetate.

Such choice of materials and close collaboration with customer on design of mouldings etc., is of course part of Insulators' normal service. But it is nevertheless moulding technique in its most proficient form, involving as it does 11 distinct and intricate moulds; this sets a seal on any firm that can execute it.

(The "Loudspeakerphone" is manufactured by The Edison Swan Electric Co. Ltd., by whose courtesy the photographs are reproduced.)

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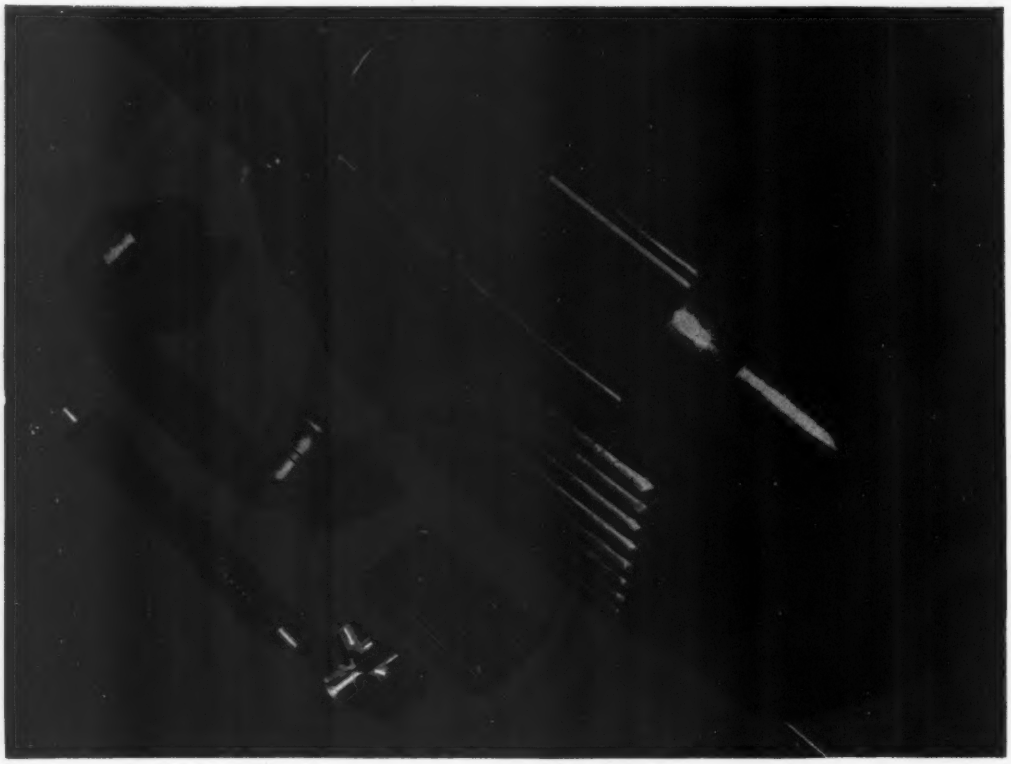

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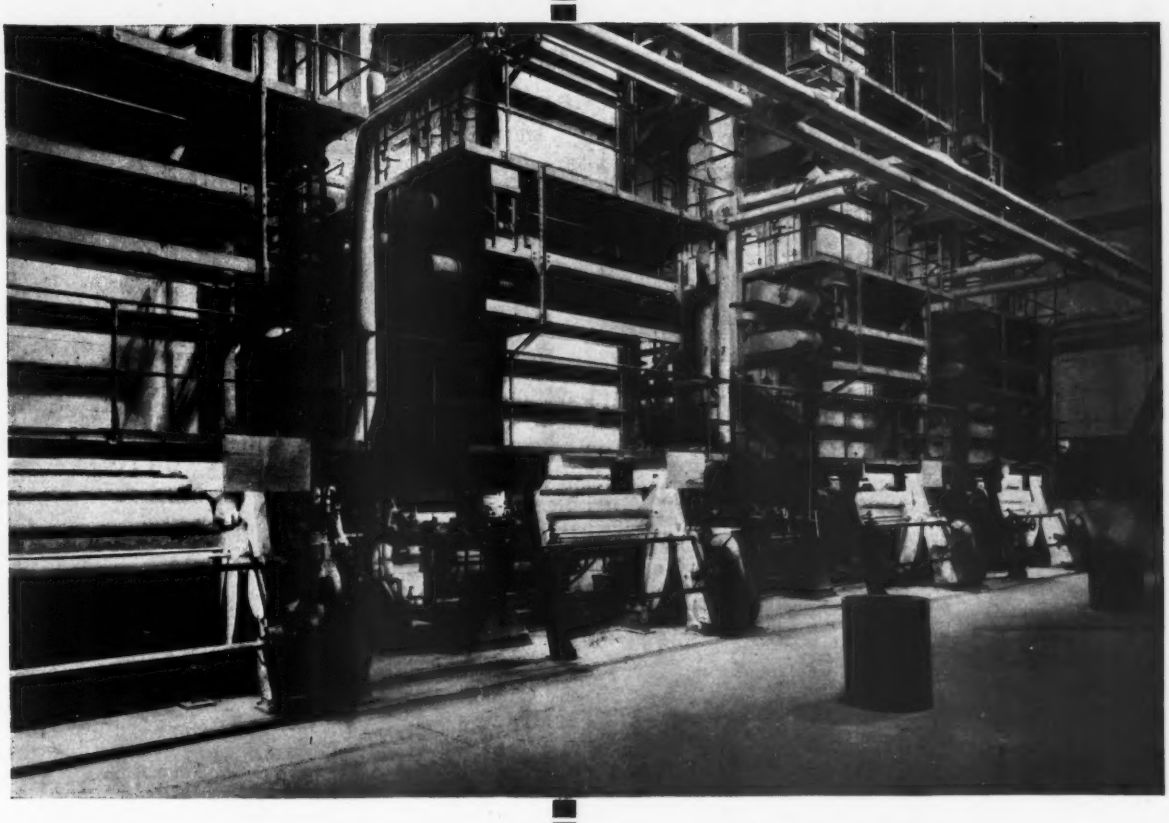

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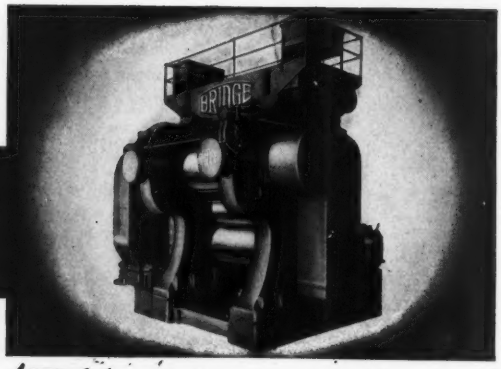

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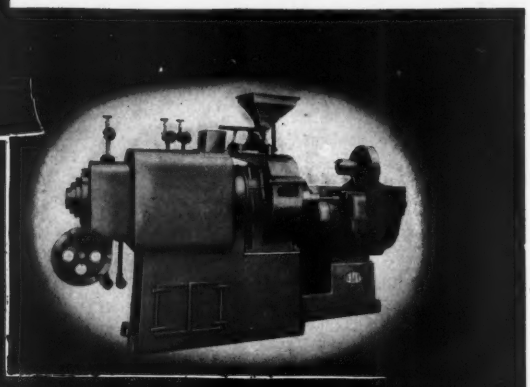

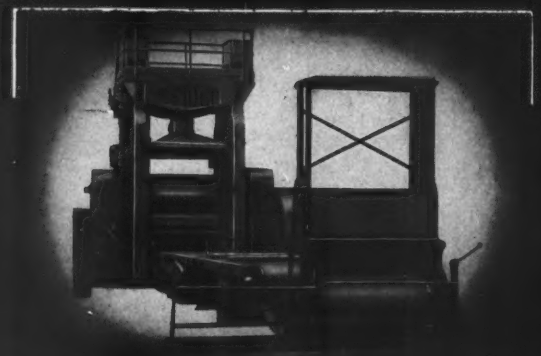

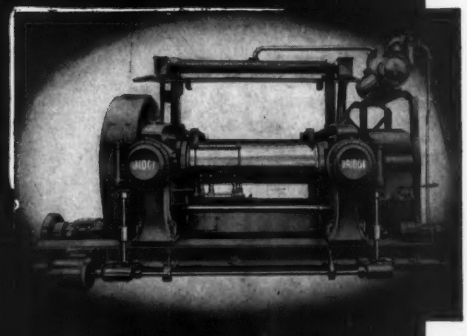

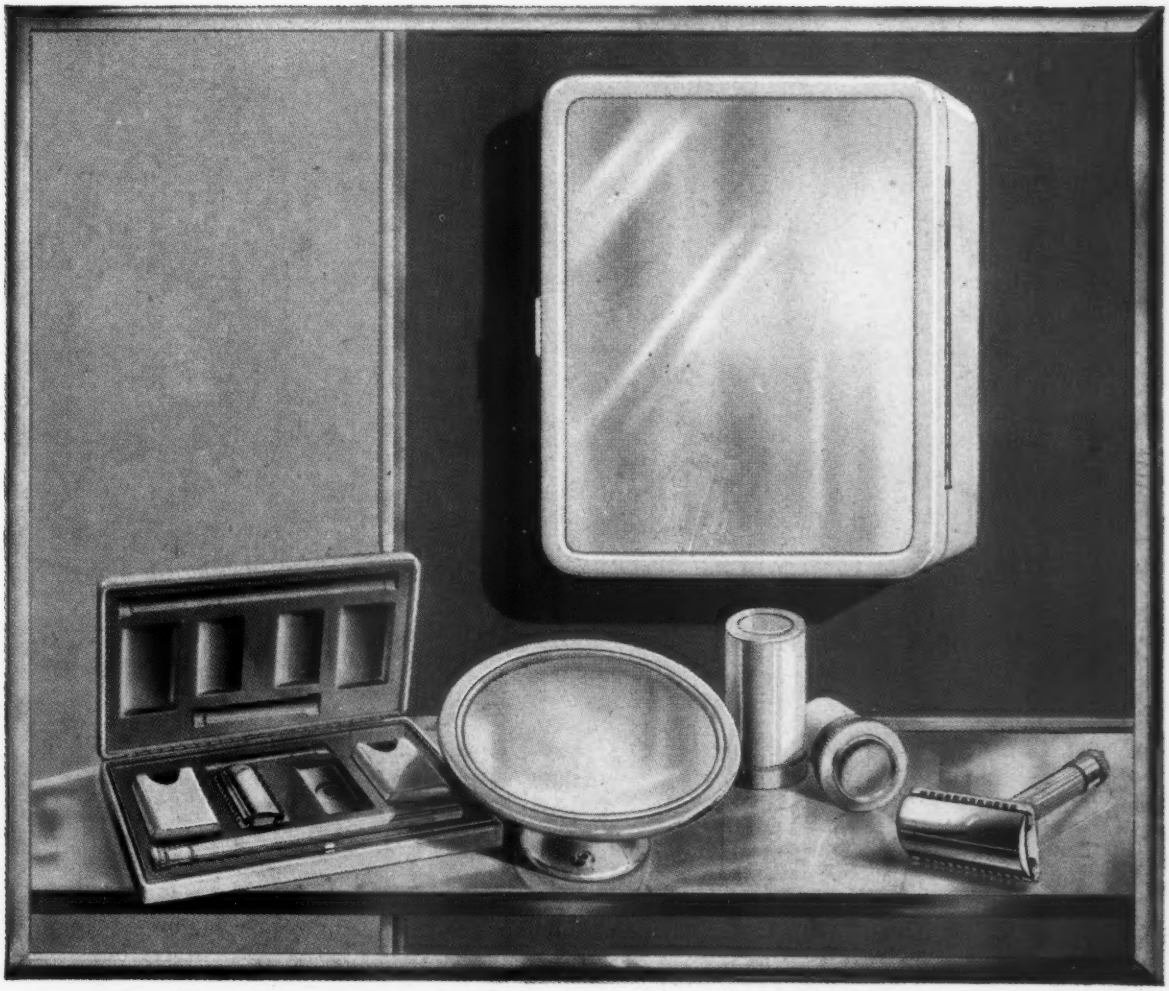

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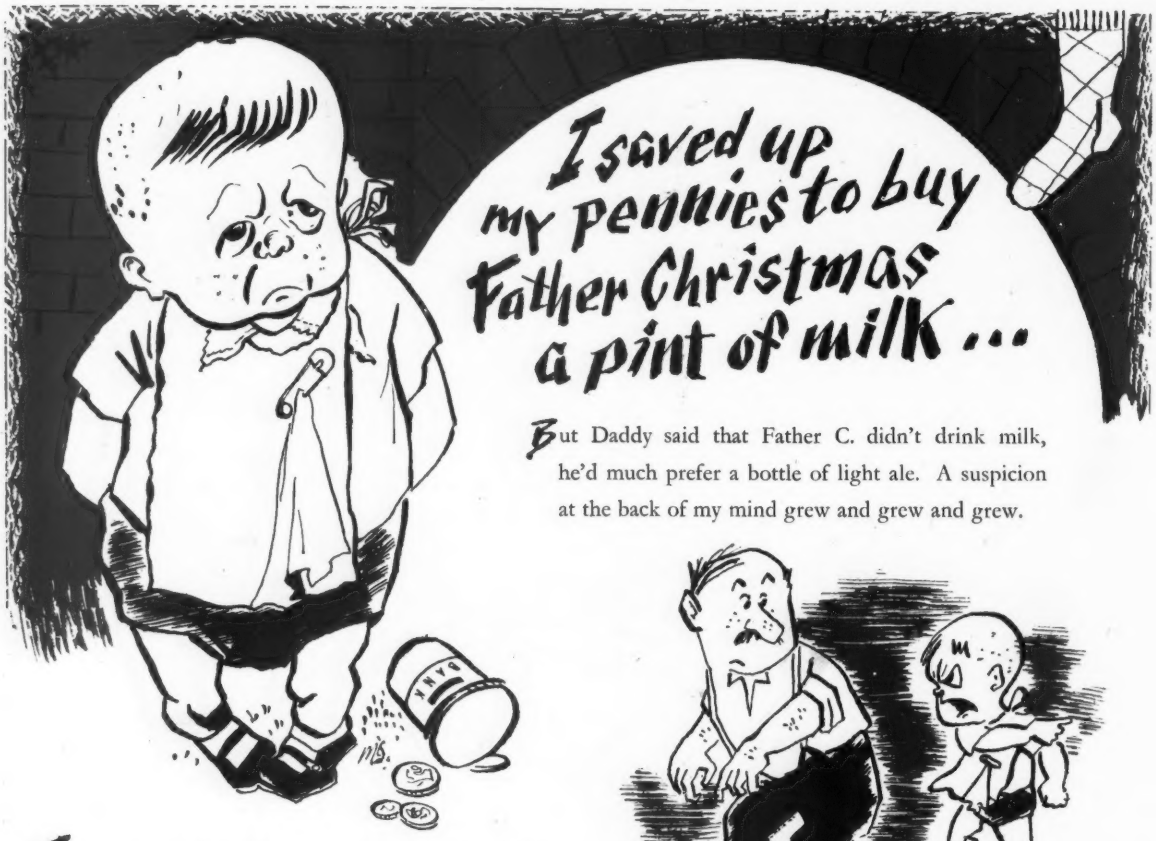

But Daddy said that Father C. didn't drink milk, he'd much prefer a bottle of light ale. A suspicion at the back of my mind grew and grew and grew.

Then the world tumbled about me. What values were there left? What in this treacherous world was plainly what it claimed to be?

I faced my father, alias Father Christmas . . .

"For the sake of my reason," I said, "point to something that is not meretricious, something that I can pin my faith to when I'm beset by creditors and buffeted by the hot winds of human indiscretion."

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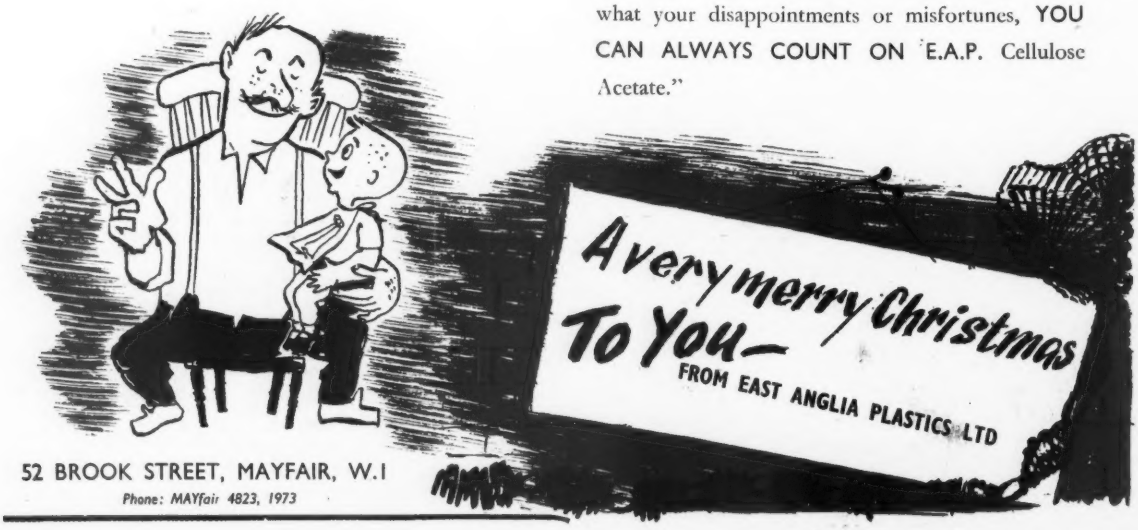

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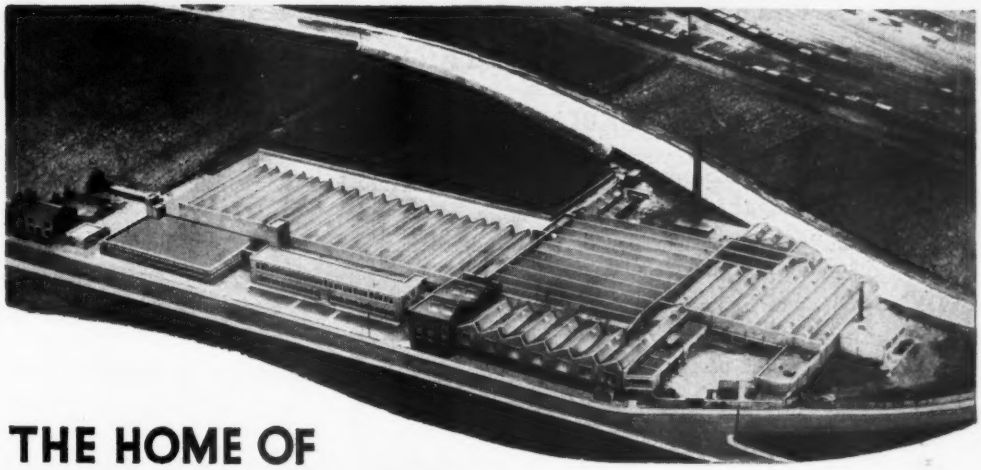

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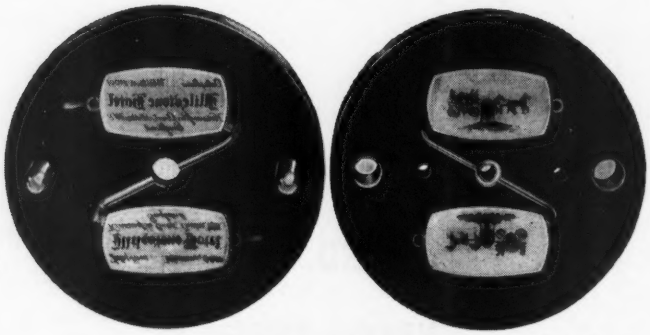

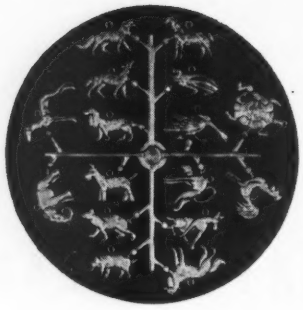

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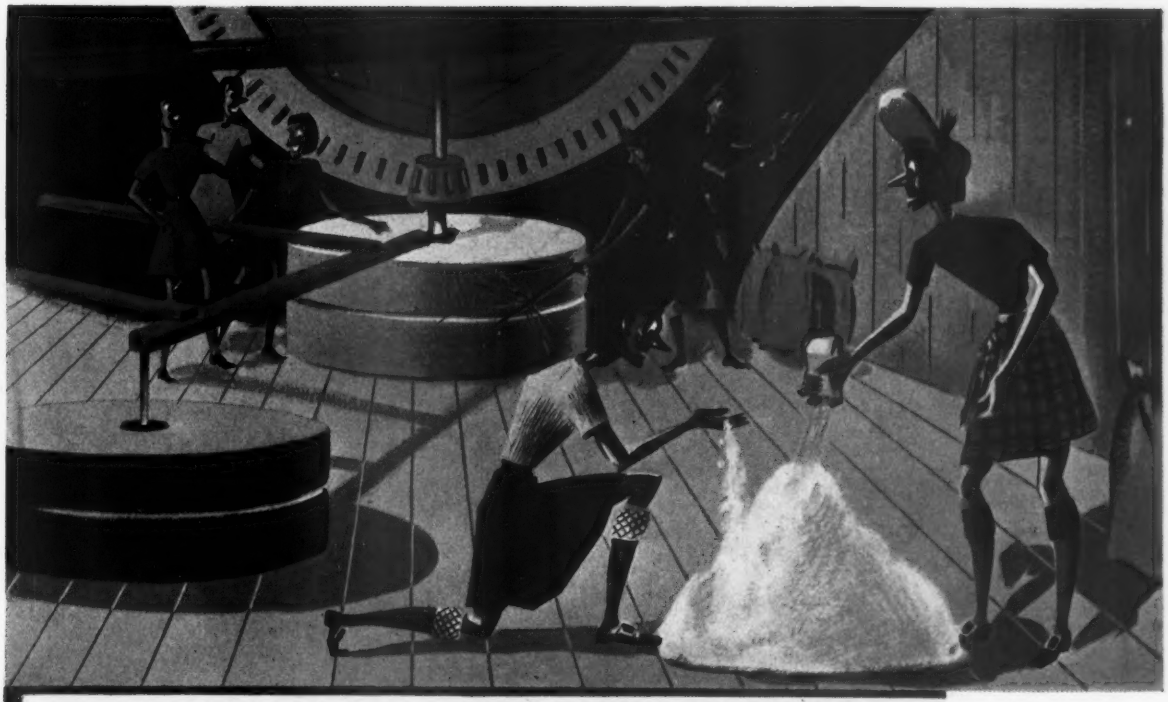

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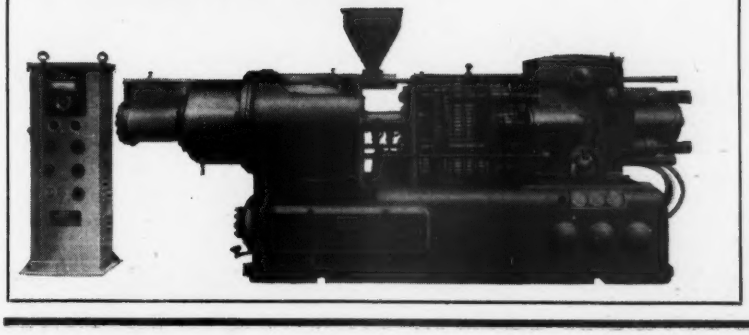

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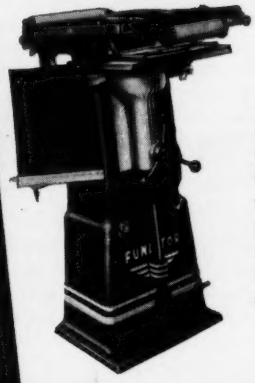

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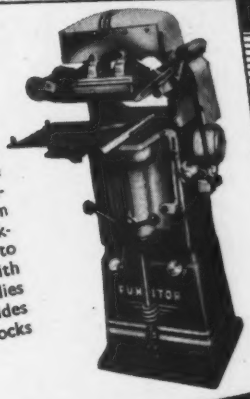

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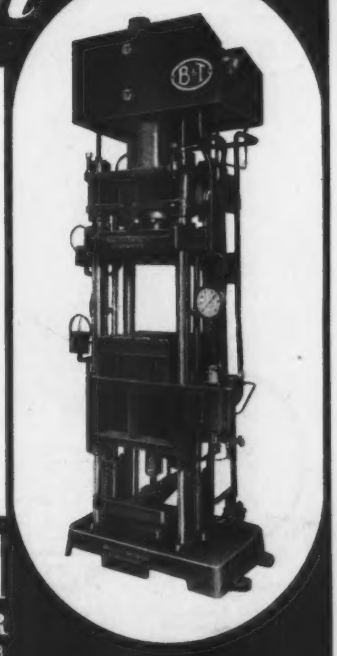

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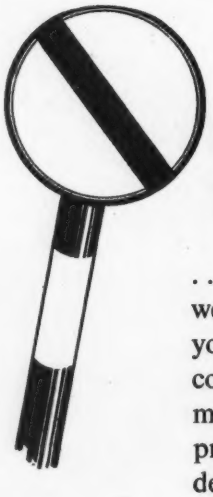

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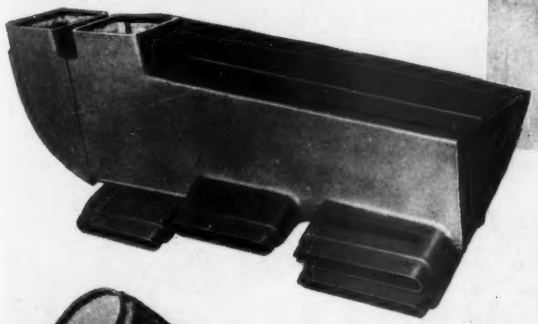

● *The illustrations show air conditioning ducts for the "Bristol" Type 175 Medium Range Airliner made from Durestos Asbestos Felt Moulding material.*

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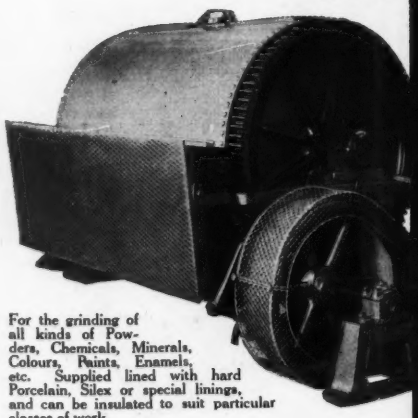

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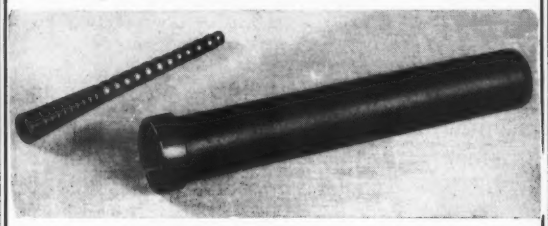

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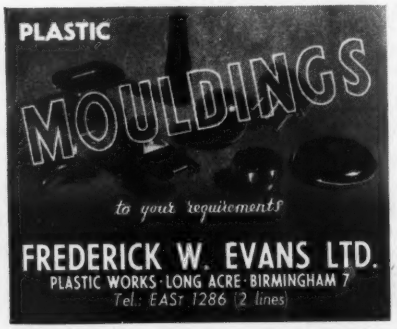

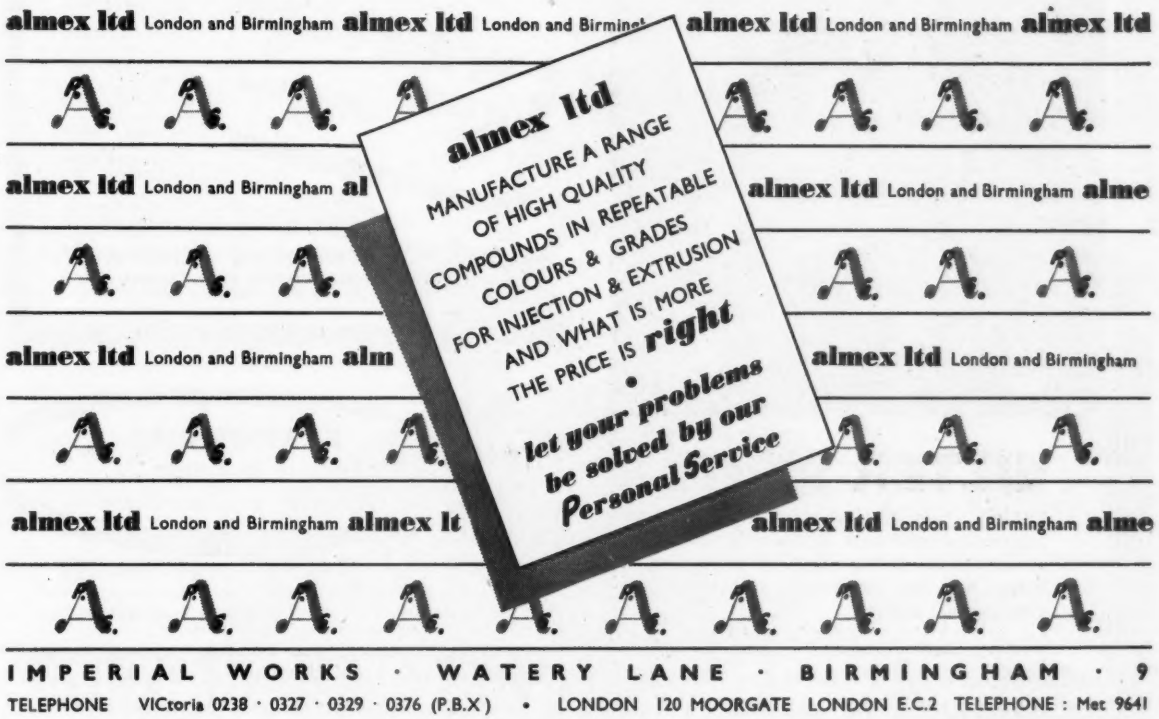

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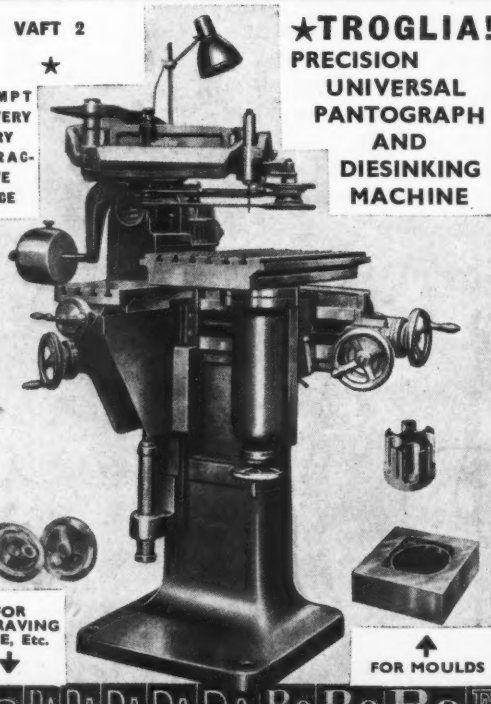

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